Bandwagons I Have Known

N. W. Simmonds, The Edinburgh School of Agriculture, West Mains Road, Edinburgh, EH9 3JG

INTRODUCTION

I've been mixed up in agricultural research, much of it tropical, for nearly 50 years and have seen plenty of bandwagons rolling by; indeed I've actually been on a couple of them myself for a little while. A bandwagon is merely the obvious response to a new idea or technique which promises well; if you can't beat 'em, join 'em. And, if the bandwagon is a good one (allied to competent publicity), it becomes a gravy-train: a seat on it nearly guarantees funds, grants and other goodies such as easy (and not too roughly refereed) publication, attendance at conferences and so on. Bandwagons, while they roll at all, roll smoothly and admit of no uneasy instabilities such as cause boats to rock. Boat-rockers, dissenters, sceptics, the most useful people in science (but the least popular with bureaucrats), have no place on bandwagons unless, very occasionally, they invent new ones, whereupon they usually have the good sense to get off, but quick. A good bandwagon rolls briefly, stops and is scrapped, the useful bits having been incorporated in current knowledge. The paradigms have then shifted, to use the OK phrase. No doubt DNA was, briefly, a bandwagon but it quickly and inevitably became a paradigm shift: however, it spawned other bandwagons of which the giant specimen, biotechnology, still rolls on, as I shall remark below. So good bandwagons quickly disappear: it's the dim ones that survive far past any useful life and it's some of those I'm talking about in this article, the ones that ought to have been ambushed long ago.

I've been sniping at bandwagons for years but have only just appreciated what an excellent word it is in the context. Chambers remarks that a *band* is, among other things, a group of persons with a common purpose, for example a troop of conspirators. It goes on about the vehicle, the *bandwagon* itself, as:

> *The car that carries the band in a circus procession; a party drawing new members by the prestige or possible advantage it seems to offer; a fashionable movement.*

Well, you can't say fairer than that, can you?

I guess that some working scientists, especially those that actually live on bandwagons, wouldn't like to admit that they even exist, still less that they represent a lamentable waste of resources. They'd prefer to call them 'the Frontiers of Science' or some such. Most people, however, know that they are there, though each, writing from a different viewpoint, would compose a different list. We've all got our fancies, often called prejudices by others. My own prejudices, outlined below, spring from my experience, mostly but not wholly, in applied genetics/plant breeding, spread over a long time in many places. I don't believe that this area of science is worse than any other; bandwagons are everywhere and the important trick is to recognise the bad ones that roll too long. I propose to write here about six of my favourites.

EXAMPLES

The first bandwagon I want to treat is **induced polyploidy** which rolled in the late 1930s and 1940s and stopped in the 1950s. It grew out of the quick squash techniques for studying chromosomes that became available about 1930 and from the discovery that the drug colchicine, besides being a useful treatment for gout, also disrupted mitosis and sometimes doubled chromosome numbers. From the 1920s it had been known that polyploids, or some of them at least, showed *gigas* characters in comparison with diploids. The (in retrospect) innocent belief that big had to be good gained ground, so hundreds of new autopolyploids were made. The cytogenetic bits of the 1950 Stockholm Botanical Congress were loaded with 'colchiploidy' as it was, alas, sometimes known. Then disillusion set in: vegetative *gigas* characters, it appeared, had more to do with moisture content than dry matter production; large tetraploid grains of normally diploid cereals (rice, sorghum, barley) turned out to be a consequence of infertility and bad seed setting. I was convinced for years that the large fruits of triploid bananas had something to do with ploidy but I'm not so sure of that now and even the potato story is not what it once seemed. The last remnants of 'colchiploidy' in plant breeding are probably the tetraploid rye-grasses: I suspect that no-one believes that they are really any better than diploids, only that they are easier to register for Rights.

My second bandwagon is **induced mutations**. This useless, even baneful, activity goes back to Hermann Muller's important work on *Drosophila* genetics in 1927. Muller richly deserved the Nobel Prize he got but it was others, not Muller, who reckoned they were going to revolutionise plant breeding. Energetic short-wave radiation had long been available from diverse sources but it was wartime 'nukery' that really got the bandwagon rolling. Physicists and governments with uneasy consciences reckoned that 'Atoms for Peace' was a pretty good slogan. Anyone, but anyone, could get a cobalt (or whatever) source, never mind whether he had or had not the (not inconsiderable) plant breeding skills required to use the products. The International Atomic Energy Agency (IAEA) was set up in Vienna, the bandwagon rolled and, so help us all, rolls still. In the plant breeding context, it has generated mountains of mostly disreputable literature, some trivial ornamental mutants and nothing of any practical consequence. (Claims for the marvels of Pallas barley usually omitted mention of the fact that semi-dwarf barley mutants were two-a-penny anyway.) Radiation-induced mutations have mostly been displaced in recent years by chemically-

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induced ones but without affecting the story of a monumental flop: a bandwagon that never delivered the goods and should have stopped decades ago. Induced mutations have scientific uses but, so far, no practical ones. Plant breeders already have plenty of mutants; the difficult trick is to use them efficiently.

As a third bandwagon, take **crop physiology**. I have nothing against the subject as a science in its own right or as an adjunct to crop husbandry. I even know two or three books that I am willing to recommend to students of plant breeding; perhaps I had better not cite them here lest I be thought to disrecommend some others (all too often symposial mishmashes). But the benign aspects are, alas, at least balanced by less reputable ones, in particular by practitioners who (eager, perhaps, for quick fame) claim to be about to revolutionise plant breeding, undaunted, it seems, by the recurrent failure of their predecessors to do any such thing. Way back, around 1960, nitrate-reductase suddenly sprang into prominence as an enzyme that would predict yield potential (it didn't). Then, erect leaves suddenly became fashionable, because of supposedly favourable light-interception properties but were soon forgotten. A little later, mitochondrial complementation became all the rage but plant breeders asked for decent experimental evidence and it sank without trace. In the 1970s, C_4 metabolism was also temporarily fancied as a general means of enhancing dry matter accumulation but it is an ecologically specialised adaptation irrelevant to most crops and most environments and probably not manipulable even if it were desirable to do so. It works fine in maize and sugar cane because Nature put it there but not in barley or potatoes, where Nature didn't. So Nature provides C_3, C_4 and CAM plants but physiologists are not about to revolutionise plant breeding because of that fact.

But the most pervasive bit of crop physiology is the 'harvest index' which is merely the ratio of useful product to total crop material on a dry matter basis. Many breeders have been reducing the sizes of plants and increasing the per-hectare populations of diverse crops for decades and thought nothing of it; that was simply the obvious way to higher yields (if that was what you wanted). But call the ratio a 'harvest-index' or 'partition-ratio' or something and it became physiologically respectable, could be included in an 'ideotype', a sort of ideal plant. Surprise, Surprise! Ideotypes looked like what plant breeders had been doing for ages, which led one admirably sceptical crop physiologist to refer to his as the 'retrospective science'. Not that the 'harvest index' was ever any real use to breeders. It was much more laborious to measure than yield alone and, if one wanted yield, it was more efficient simply to select for yield and take the HI along as a correlated response if that's how it was in that material. (Obviously, a plant with high HI may have an abysmal yield, and sometimes does.) More generally, the 'ideotype' idea may have its moments but there's no guarantee of uniqueness and why should there be? Back in the 1960s Donald McColl sought a sugar cane ideotype as part of our West Indian breeding research programme; he concluded that there were several routes to good sugar accumulation but no one ideotype, no quick selection fixes. Neat job, end of project, end of story. Sugar cane breeders want tonnes of sugar not an ethereal vision of a Platonic Ideal.

So the crop physiological bandwagon rolled and, alas, rolls still. I have seen several recent additions to the unnecessary (mostly symposial) verbiage. Plant breeders won't bother to read them but scarce resources are still being wasted and one fears that bureaucrats, granting agencies, councils and committees with built-in biases aren't always too clever at distinguishing science from science-fiction or fact from fantasy.

My next, fourth, bandwagon rolled in the 1960s but, I suspect, started well before then. It was founded on an ancient piece of nutritional mythology called '**The Protein Gap**'. The mythology (based on anecdotes about dietary preference rather than physiology) had it that human needs for protein were enormous and that the starving of the world weren't hungry for energy or even food but for those vital proteins. FAO, alas, helped to promote the myth. There was even a popular journalistic phrase, echoed to this day: 'empty calories'. Slowly, the nutritionists got their act together and, nowadays, we recognise that hunger is still dreadfully common but acute protein shortage is rare. It is, indeed, quite difficult to eat enough calories in a *reasonably diverse* vegetarian diet without consuming an adequate protein supply. So much is now widely known. Less well known is the nutritional value of non-seed proteins: one could eat an adequate protein diet from potatoes boiled in their skins before getting enough energy from starch ('empty calories', remember?). One would also get 'potato-belly' from sheer bulk. Grains are nutritionally inferior to potatoes but are more conveniently packaged and storable products.

This bandwagon ran to a standstill in the 1980s but a subsidiary bandwagon rolls on even now, though decelerating. This one concerns protein quality rather than quantity. Seed proteins, cereal or legume, tend to be unbalanced for human nutrition, so breeding high-lysine cereals became all the rage and mopped up lots of resources that could have been better used elsewhere. The protagonists generally failed to note that cereals and legumes complemented each other and that vegetative proteins (such as those in potatoes, brassicas, spinaches) were nutritionally excellent. This didn't stop the bandwagon, though, and, even now, dead as the project is, or should be, a trickle of verbiage still flows. There was even a special phrase (HQPM, high quality protein maize) coined to describe the high-lysine product, an economic aberration if ever there were one. In the HQPM context, there was once an economist who asserted that the government of a certain tropical maize-eating country should declare all other kinds of maize illegal, even though the local folk didn't like the new product. And economists are sometimes heard to wonder why their

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thoughts are received with scepticism!

I have dropped many bricks in my time, some purposely, some accidentally. My most treasured accidental brick descended when I once remarked to a man at a meeting that it was high time all this high-lysine nonsense was stopped. I thought his name was Smith but he flashed his lapel-label at me and it wasn't. He was one of the inventors of the bandwagon and he was just a little peeved. I was embarrassed but unrepentant. If you run bandwagons, you run risks.

My fifth bandwagon is relatively recent and still rolling. It is **Farming Systems Research** (FSR). (Yes, I know FSR also means Flying Saucer Report, a perfectly good bandwagon, too, related to circular lodging patterns in cereals, but irrelevant here). Understanding of farming systems (FS Perspective in the jargon) goes back into the dim mists of history, in those wicked Colonial days, as I have recently pointed out in these columns. FSR as such emerged in the CGIAR system in the 1960s and 1970s and was, within limits, a Good Thing, because it encouraged socio-economic understanding among researchers (especially among those with little experience of tropical agriculture) of what agricultural research might or might not do for tropical small farmers. At best, this is still true. But, alas, the subject in general blew up into a sociological balloon and, nowadays, no research enterprise is complete without a gaggle of sociologists telling each other and everyone else what to do. Interdisciplinary teams are bureaucratically very OK but interdisciplinary thinking (which would be much more useful) remains scarce. Our deplorably narrow Euro-American PhD system has much to do with this scarcity, I suspect. I look forward to meeting, some day, the bright young man who knows all about Ultraseptic Analphabets but doesn't know a yam from a sweet potato.

FSR, sensibly exploited, must have its uses, of course and there have been some highly illuminating socio-economic insights. The risk, a serious one, I think, is that the sociology, with its attendant windy blether, takes over from the science as the real-life objective. That way, at least, one could never be proved wrong. One hopes that the bandwagon stops before the delights of talking about what research other people should do actually replace the doing of it.

My sixth and last bandwagon is the biggest and best (or worst, depending on viewpoint), namely **Biotechnology**. The word, a horribly loose one that might be thought to take in baking and brewing, has come to mean more or less any manipulation of biological material in sterile culture in the laboratory. At the simplest limits, plant breeding biotechnology is old hat; plant breeders have been doing it for years, in the form of embryo rescue (back to the 1920s) and shoot-tip culture (mericulture) (around 1960 onwards). Mericulture has been a key element in rapid multiplication of disease-free clones and of pricey horticultural varieties for years. All this, of course, doesn't stop journalists from simply loving pictures of little cassava or banana plants in tubes and referring them to Biotechnology (with a respectful capital B). Move down the line, away from organised embryos and meristems, to calluses, cells and protoplasts and things become more complex. Regeneration is usually difficult, often impossible, though it will be necessary if molecular tricks or *in vitro* somatic hybridisation are to be made to work, at a practical as distinct from an experimental/illustrative level. Furthermore, any regeneration from biologically disordered material (such as callus or free cells) is accompanied by messy cytological, genetic and epigenetic variation collectively called 'somaclonal variation', a ragbag term to cover a load of ignorance. Making a virtue of necessity, some have sought to find useful changes among somaclonal variants, so Bandwagon No. 2, induced mutation, rolls again (but, happily, not very fast). That's been good for a few grants but has been about as productive of practical results as irradiation. Fascinating scientific questions remain but there's no sign that *in vitro* operations will be any more than marginally useful in plant breeding, though they certainly have a place in propagation.

Further down the line still, we enter the molecular field and what might be called biotechnology proper. Here there is a real prospect of changing, moving, inserting, inventing genes (DNA) on a considerable scale, albeit at great cost. Some fields, such as microbiology, medicine and pharmaceuticals are fairly certain to be much affected. Social implications are complex; hence the increasing (and ever more raucous) involvement of corporations, lawyers, bureaucrats, Greens, journalist and others. There's a lot of money and verbal mileage to be had here. Plant breeding is not so simple but agribusiness is big business and seed supply is a major component of it which is why the chemical corporations have been buying into plant breeding for the past 10–15 years. Perhaps they even believe their own hype to the effect that molecularology is about to transform that dim, old fashioned plant breeding into Modern Science. The hype has been around for 15 years but the results have not. There have been some neat experiments (yes, transgenosis tricks have worked on *Petunia* and tobacco); elegant but expensive diagnostics using RFLPs (restriction fragment length polymorphisms) are in prospect and may be marginally useful there may even be the odd workable virus coat-protein resistance gene to be had (which is a nice idea though yet unproven). But a revolution is not in prospect and for the simple reason that those clever chemists either don't know or conveniently ignore: plant breeding is a *statistical* process that nearly always involves several-many genes of small effect (economic characters are 'polygenic') while molecularology can only cope with one gene at a time (and that at great expense). Quantitative genetics is just too difficult for chemists. Biotechnology may be really useful sometime well into the next century but I'd want to see the crucial 10,000 hectare test passed before I'd agree that it were any

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use at all; I'd require 10,000 hectares of an excellent cultivar, freely chosen by farmers and uniquely constructable by molecular tricks.

Meanwhile, the hype flows and the bandwagon rolls. People who ought to know better have delivered, and continue to deliver, terrible verbal nonsense such as the following from 1984/1985, cited by a writer who actually believed the hype:

> *'The solutions are coming very fast new. In three years we'll be able to do anything that our imagination will get us to.*
>
> *. . . an enormity of crop production that may dwarf the accomplishments of the Green Revolution'.*

Literary criticisms aside, one observes that, on the first, seven years later, we still haven't got nitrogen-fixing wheat (a widely touted but unlikely prospect) and, on the second, that many tropical small farmers would love to hear more about the enormity but, alas, will not. The prophets, in my opinion, ought to shut up until at least a few of their predecessors have been proved correct.

All this ridicule would just be good, clean, knockabout farce were the matter not really serious. The bandwagon, as it applies to plant breeding, is expensive and damaging. Resources are being diverted from doing genuinely useful jobs to the pursuit of trendy irrelevance; biotechnology is, I think, actually accelerating the collapse of proper agricultural research. A thoughtful watch on events and prudent adoption of such usable bits as became available would have been a much wiser response.

CONCLUSION

So what's the conclusion, if there is one? I think that bandwagons are simply inevitable responses to social pressures on scientists to get in there with the boys, hoping for a piece of the currently fashionable action. If the action is backed by a few big names, lots of cash, social approval and the promise of goodies for the lucky and/or clever, then we shouldn't be surprised that bandwagons roll. They roll because, as the current ideology has it, Market Forces Rule OK. But need bandwagons roll so long, so little checked by decent scepticism? The best correctives are the nasty questions: Why do it? What for? How do you know? Who says? These questions, asked loudly and repeatedly, should stop any bandwagon when it has served its purpose. We ought to ask them more often, not least because the worst bandwagons go beyond mere laziness or wasteful me-too-ism and verge on the intellectually dishonest.

[Members may like to add their own favourite bandwagon. Ed.]

From Centre for Arid Zone Studies

Pearl Millet Downy Mildew

Pearl millet (*Pennisetum americanum*), one of the staple food crops in the semi-arid tropics is grown mainly in India and the Sahelian zone of West Africa. Of the diseases affecting pearl millet, downy mildew (*Sclerospora granicola*) is the most destructive and widespread. Breeding programmes have produced resistant varieties, but disease resistance breakdown occurs regularly and no cultivar has yet been generated that is stably resistant over all growing regions. Work by Sarah Ball (University of Reading) indicated that host cultivars exhibited a variable response to pathogen collections taken from different regions. This project's initial work has included the study of the F4 progeny from two downy mildew resistant susceptible crosses; the susceptible parent being the same in both, so that any variation in downy mildew distribution in the F4 can be attributed to the genetic differences of the resistant parents. Downy mildew screening was carried out at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India. Results showed genetic differences between the resistant parents. The data produced from this will be used in a quantitative trait loci (QTL) analysis, utilising the pearl millet restriction fragment length polymorphism (RFLP) map that is being constructed in the Cambridge Laboratory, Norwich.

Who Makes Money Out of Food – A Worldwide View

Conference held on 23/24 November 1991

Farmers have been likened to the filling in the sandwich, caught between the suppliers of their inputs and the consumers of their products. They are under increasing pressure from many conflicting quarters:

> supermarkets for attractive products, consumers for low prices, environmentalists for a responsible attitude to production and from government policies which create the economic environment in which farming operates.

Farmers all over the world are facing similar problems, and clearly for those in the developing world the difficulties are more extreme.

> 'Is co-operation the key to a successful farming future?'
> 'How practical is on-farm processing for added value produce?'
> 'How are the problems tackled in developing countries – can we learn from each other?'
> 'Have consumers been alienated from their food sources and if so, can they be put back in touch?'