years, the PAs are allowed to present the intermediate results (labelled 'preliminary') in conferences and symposia and any other similar forums, including presentation for job interviews. Thus till the results appear in print with all the authors, the PAs retain their individual possession. Of course, in a collaboration all the results, whether preliminary or final, belong to the collaboration and if someone other than the PAs is required to present those results, it is always made available. Noting that it is not always possible for each and every student to make presentation in major international conferences, the collaboration encourages the young members to take advantage of several local (national) symposia and conferences, where he can get a chance to make a presentation of the results of the analysis. The slides of any presentation and write-up for the proceedings of conferences have to be usually vetted by PWG and PAC. Unilateral presentation or even submission of abstracts is not allowed. In the case of students it is also required that he must give a rehearsal presentation at least among the local group members in the presence of the Council representative of that institution who in turn will certify to the collaboration about the general standards of slides and physics claims. Publication of the work in all the conferences is normally with only one name (of the person making the presentation), with the collaboration's name added. This also amounts to almost an individual contribution.

It is thus clear that while the analysis of the data is done by a few people (the PAs), the collaboration as a whole retains the responsibility for the authenticity of the results and the physics conclusions drawn from the data. Hence the entire collaboration claims authorship. There have been instances where a particular person (or persons) may not agree with the analysis and the conclusions drawn. He can then withdraw his name from the authorship list, so he feels satisfied that at least he is not going to be responsible for that particular set of results. The authorship policy in large collaborations has been the subject of intense discussions within the community. Even the IUPAP sub-committee on physics had once appointed a committee to look into various aspects and come up with suggestions that would result in smaller number of authors reflecting significant individual contributions. But no acceptable scheme has yet been found.

We find that while being part of a large authorship article does not necessarily mean that one has contributed significantly, one can always distinguish between the PAs and the rest of the authors. The collaboration does not use the full authorship list for work done in connection with instrumentation or the development of certain analysis methods, etc. These are published with only the names of the workers directly involved and have small number of authors like in any other branch of science. The collaboration also publishes its own 'internal notes', which again have less number of authors and are subjected to refereeing by experts within the collaboration. Such works may not have very wide application, but are important for the progress of the physics programme of the collaboration.

Now that we have seen the details of the working of a large collaboration, we can easily formulate a scheme for the evaluation of young workers in this branch of science. Simply going by the large number of publications should not be any reason for acceptance as a bright candidate. Nor should the large number of authors be any reason for rejecting the claim of any good candidate. Our focus should be on the number of articles in which the worker remained one of the PAs, the number of conference presentations, invited talks, short notes published by the collaboration, other publications with less number of authors, etc. These are the works where the individual contribution is reflected most and the concerned person should also possess detailed knowledge of such works. If these are taken into consideration by the scientific community of our country, I am sure there will be justice done to those young workers involved in large collaborative experiments and slowly but surely the community will come to appreciate the importance of this branch of research.

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Soil responds to climate change: is soil science in India responding to?

Manoj-Kumar

Concerns about the likely impacts of climate change on agriculture and the possible implications for future food security have recently fuelled a plethora of research across the various disciplines of agricultural science. This has now fairly improved our understanding of the climate-change impacts on agricultural productivity in different regions of the world. Increasing concentrations of atmospheric CO_2 and the accompanying rise in the earth's surface air temperature, by virtue of their come-along effects, have been recognized as the two most important climate change-associated factors expected to impact crop productivity across the globe. Since atmospheric CO_2 is the sole source of carbon for plants, variations in its concentration have obvious implications for plant growth[1]. The best growth and yield performances of C_3 crops (e.g. wheat and rice) are observed at around 1000–1200 μmol mol^{-1} CO_2 concentration[2,3], implying that the current atmospheric CO_2 concentration (ca. 385 μmol mol^{-1}) is insufficient to saturate the productivity potential of C_3 crops, and hence, any further increase in atmospheric CO_2 is expected to increase the productivity of these crops[4,5]. Unlike the globally observed positive effects of elevated CO_2, impacts of rising temperature are expected to be highly region-specific. Increasing temperature in temperate and polar regions, where crop growth is currently limited by unfavourably low temperature regimes, is expected to reinforce the beneficial effects of elevated CO_2 on crop yield. However, in the tropical and subtropical regions where most of the food crops are already growing at the upper limits of their thermal tolerance, higher temperature may offset the beneficial effects of rising CO_2 (ref. 6).

India has strong reasons to be concerned because atmospheric warming has already started to make its impact felt on Indian agriculture, as evident from the stagnating crop productivity in recent years which, to a certain extent, has been ascribed to terminal heat stress caused by rising temperature. The impact is further projected to assume a disastrous proportion in future. In such a scenario, the yield-boosting effects of higher CO_2 would be critically important in reducing the yield loss caused by elevated temperature. However, the positive effect of CO_2 fertilization on crop yield is observed only when the soil has enough available nutrients, nitrogen (N) and phosphorus (P) in particular, to sustain higher growth rate of plants under elevated CO_2 (refs 7 and 8). This implies that future sustainability of crop production, to a great extent, will depend significantly on the availability of the major nutrients in the soil to meet the higher nutrient demand by the plants under changing climate. Climate change-induced increase in nutrient demand of the crops could be of particular concern to India where majority of the agricultural soils are already deficient in N and P availability, with their deficiency further intensifying over time due to heavy nutrient mining caused by intensive cultivation coupled with inadequate fertilization.

The most pertinent questions arising in this context are: how will the changes in climatic variables affect nutrient availability in the soil? Is there any possible biochemical adaptation in the soil to increase the availability of nutrients under changing climate? And, what are the other climatic impacts on the soil and soil processes which can affect the sustainability of crop production in the future world of changing climate? Experimental observations across the various agro-ecosystems of the world, although the results are quite contradictory and inconsistent, reveal that the soil and soil processes do respond to changes in climatic variables. Organic matter, the most important component of the soil which stores and supplies essential nutrients such as N, P, S and micronutrients to the plants, is expected to be directly affected by climate change, particularly in the warmer regions of the world. Rising temperature can hasten the rate of organic matter decomposition and thereby accelerate the already declining status of organic matter in India with an obvious impact on soil fertility. Increase in soil temperature can also enhance the rate of N mineralization, but its availability may decrease due to increased gaseous losses through processes such as volatilization and denitrification. The quality of soil organic matter may also decline with increasing share of inert components in the soil carbon pool. As the N concentration in plant tissues is widely reported to reduce under elevated CO_2, the consequent increase in C : N ratio of the crop residues may reduce their rate of decomposition and hence nutrient supply to plants in the long term.

In view of the widespread deficiency of phosphorus in agricultural soils world over, it could be the most important plant nutrient, after nitrogen, which can limit crop productivity under high nutrient-demanding agriculture in the changed climatic scenario of the future. However, while the source of nitrogenous fertilizer (molecular N_2 in the atmosphere) is practically infinite in nature, that of phosphorus (phosphate rocks) is expected to exhaust in the next few decades making it the most critical plant nutrient for the future[9]. Given the fact that about 98% of Indian soils are already inadequate in P availability[10], and the country depends almost completely on foreign imports of P fertilizers, further increase in crop P demand induced by climate change can potentially challenge the sustainability of agriculture in India. However, in response to enhanced P demand by the plants, certain biochemical processes in the soil may show compensatory adjustment/adaptation responses in order to increase the availability of P in the soil. Increased activity of P-mineralizing phosphatase enzymes and P-solubilizing organic acids (e.g. citric acid, malic acid, oxalic acid, etc.) in the crop rhizosphere (which converts the unavailable soil P into plant-available form) could be some of the possible mechanisms for this. Conversely, the increased microbial activity observed under elevated CO_2 due mainly to increased carbon flux in the crop rhizosphere, can immobilize the soil nutrients, thereby making it less accessible for the plants. Differential responses of the availability and uptake dynamics of different soil nutrients under rising atmospheric CO_2 and temperature can also alter the interactions among various macro- and micronutrients (such as N, P, Zn, Fe, etc.) in the soil and plants, with their definite impacts on the yield and quality of the crops. Furthermore, the higher doses of fertilizer (N and P) application seem inevitable in future to meet the enhanced nutrient requirements by plants grown under elevated atmospheric CO_2. As fertilizer is the most costly input in agriculture and its use-efficiency is associated with several environmental hazards as well, it is quite pertinent to enquire how efficiently these applied fertilizers will be recovered and utilized by the plants under the future scenario of climate change. The question assumes more relevance in Indian agriculture, where fertilizer use-efficiency is among the lowest in the world.

Having looked at the possibilities of climate change-induced alteration in some of the important soil processes and their relevance to the future sustainability of Indian agriculture; it is rather tempting to know 'how well the soil science in India has responded to the impending challenges of climate change?' Despite the growing recognition of the soil as a possible victim of climate change, and consequent alteration in soil processes as the regulating factors of crop response in the future, nothing substantial has been done by the soil scientists in India to assess the impact of changing climate on the soil and rhizosphere soil processes mentioned earlier. An overview of the research papers concerning soil responses to climate change, published in major soil science journals in the last 10 years, presents a dismal picture as far as the efforts and contribution of the Indian researchers are concerned. Barring a few sporadic reports on the changes in soil carbon pools[11], information on the soil processes involved in nutrient transformation and availability in crop rhizosphere as influenced by changing climatic variables is almost non-existent. The possible alteration in the use-efficiency of applied fertilizers (the most costly input in Indian agriculture) under climate change also remains unattended so far[12]. It is paradoxically surprising that while India is being projected among the worst-hit countries by climate change owing to its devastating impact on agriculture, the response of soil science in India is far below expectations. Knowledge of the possible changes in soil fertility and nutrient availability is required for a holistic assessment of climate-change impacts on agricultural sustainability, and also for evolving an integrated strategy for climate-change adaptation in India. To this end, the soil science community in India needs to assume greater responsibility by recognizing and responding to the challenges posed by climate change, so that food security for more than one-sixth of humanity can be ensured in the future.

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A new conservation policy needed for reintroduction of Bengal tiger-white

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The conservation value of the Bengal tiger-white which is chinchilla albinistic has been discounted on the notion that the whole population has descended from a single white male caught in the jungles of Rewa, Madhya Pradesh, in 1951, which was later named Mohan[1]. But empirical facts prove otherwise. Although it is true that the Rewa strain of white tigers originated from Mohan, subsequently another strain of white tigers was born in 1980 to orange-coloured Bengal tigers at Nandankanan Zoo, Bhubaneswar, Orissa, which have their ancestry from a different forest area[2–4]. The multiplicity of sightings of the Bengal tiger-white in a vast area ranging from central India to Assam also point in the same direction.

Between 1920 and 1930, fifteen Bengal tigers-white were killed in the forests of Bihar[5]. The Tiger Species Survival Plan devised by the Association of Zoos and Aquariums has condemned the breeding of white tigers on the allegation that they are of mixed ancestry; hybridized with other subspecies and are of unknown lineage. Although this is true of offsprings that have originated from a cross between the Bengal tiger-white and the Siberian tiger which are found in the US, it has no application to the Bengal tigers-white kept in Indian zoos.

Incessant inbreeding for several generations leads to the expression of deleterious traits in animals[6,7]. This can be observed among Asiatic lions[8], Bengal tigers and Bengal tigers-white. But there are, in Indian zoos, several healthy Bengal tigers-white born to heterozygous recessive Bengal tiger parents which are only carriers of the white trait. The genes that are responsible for deleterious traits and deformities are not directly linked to white pigmentation. The only exception to the above is Strabismus or crossed eye, which is known to have a direct link to the gene causing white colour. But this has been observed outside India mainly among white tigers with mixed Bengal and Siberian ancestry but for one exception of a Bengal tigress-white, Rewati in Washington DC[9,10]. A few isolated cases of arched back, clubbed feet and still birth have been reported from the Delhi zoo during the 1960–1970s (ref. 11). But in the recent past, there have not been reports from Indian zoos of any such occurrences exclusively in the case of Bengal tigers-white. It cannot, therefore, be categorically asserted that the above abnormalities were due to white pigmentation. Abnormalities can also arise due to lack of proper diet, maintenance or inbreeding.

Analysis of data from the Central Zoo Authority of India shows that the mortality rate among Bengal tigers-white (6.73%) in all Indian zoos put together is lower than that of Bengal tigers (8.19%) for the five-year period (2004–2009). Likewise, the birth rate among Bengal tigers-white (12.74%) is much higher than that of Bengal tigers (4.93%) for the same five-year period. The comparison between the respective mortality rates and birth rates of the Bengal tigers-white and Bengal tigers shows a better survival edge for the former. The contention that the low mortality rate and high birth rate among Bengal tigers-white in zoos can be attributed to the special treatment given to them in respect of their diet and enrichment is not justified according to the enquiries made with zoos in India.

Historically speaking, the genes responsible for white colour are represented by 0.001% of the population. However, in 2008–2009, a closing stock of 264 Bengal tigers and 100 Bengal tigers-white were accounted for in Indian zoos. The disproportionate growth in numbers of the latter points to the relentless inbreeding resorted to among homozygous recessive individuals for selectively multiplying the white animals (Figure 1). The present practice in some Indian zoos is to mate two homozygous recessive white individuals to get all progeny white. This progressively increasing process will eventually lead to inbreeding depression and loss of genetic variability. Such breeding with immediate kin flies in the face of guidelines issued by the International Union for Conserva-