members. *There is an expert from the medical community, one from the agricultural community, one from the legal community, but none from the science, technology and engineering community. This needs to be corrected.*

The new proposed 'Authority' has suggested the setting up of a number of accreditation agencies by a body of professionals in various disciplines. These new agencies will have to seek the approval of the Authority to function as accreditation agencies. The role of NAAC, AICTE and MCI and other Government-sponsored bodies is not clearly specified, but they may also have to be approved by the new Authority. This model of allowing the setting up of a number of accreditation agencies (but to be approved by the Government) is similar to the US higher education model, where the private organization of the Council for Higher Education Accreditation (CHEA; www.chea.org), works closely with the US Department of Education (USDE) when accreditation of institutions using US Government funding is involved. In the US model, however, not all accreditation agencies have to be recognized by USDE, but only those that would accredit an educational institution that is receiving Government funds. Members of the public and the academic community respect the accreditation given by an agency formally recognized by CHEA.

Under the new reforms in the process of accreditation, the new accrediting agencies to be set up will be autonomous organizations, independent of the Government system. Also, these will be available for individual universities for getting accreditation for a specific purpose relevant to the expertise of that agency. The autonomous accreditation agency could be a company registered under Section 25 of the Companies Act, 1956; a society formed and registered under the Societies Registration Act, 1860; a Trust formed under the Indian Trusts Act, 1882, or any other law in force at the time.

As mentioned earlier, we have only a limited number of recognized accreditation agencies in the country. The need is enormous. In the US, there were 80 recognized accrediting agencies under CHEA, as reported in 2007. If the task of accreditation is made mandatory in India, there will be a need of setting up such agencies in a big way. *The question now is: 'Who will come forward to form such accreditation agencies?'* Do we have, in India, a large number of professional bodies (including all the science and engineering academies) who would be willing to set up such agencies of their own? Are the professional societies which carryout activities like publication of journals, organizing seminars and workshops and publishing reports keen and competent enough to start such agencies? How will they finance and structure themselves for these activities? Do they believe in, and are they committed to, the fact that they have the ethical and moral responsibilities to see that their specialized areas of education and research are pursued with high quality in the university system? Apart from this, they need to be suitably equipped to undertake this complex job of accreditation.

If the various academies and professional bodies do not come forward to take up this additional responsibility of setting up accreditation agencies, it is likely that pseudo professional groups would set up 'fly-by-night' operations, if they see financial benefits (including possibilities of using unethical practices) in such enterprises. This happened when we opened the channel of setting up of private educational institutions. Certainly one has seen some good private initiatives, but there have been some equally dubious educational institutions that were started under the garb of providing quality education. We have yet to come out of that phase when serious issues were raised in certifying 'deemed to be universities' and the unfair practices of some of them. The national academies such as the Indian Academy of Sciences (IASc), Bangalore and others have to take a lead and shoulder this responsibility of ensuring quality education in our system. The Government has opened the doors to such academies to take up this responsibility if they so wish to do so. Questions may be raised by the 'ivory-tower' regarding the role of the academies. One can only quote from the well-drafted section on 'Role of the Academy' in the *Year Book* of the IASc, which states:

> '…the Academy considers that the scientific community has a unique contribution to make not only to the flowering of science in India but also to national character'.

In my view, ensuring the pursuit of high-quality science and engineering in our university system, with the academies taking this role of accreditation, is certainly one way of adding respect to our national character. Will IASc take the lead?

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Seed-cane marketing – a multi-million industry in the offing

P. K. Singh, A. K. Singh, Sanjeev Kumar and J. Singh

Diversion of more than 10 mt of food grains for bio-energy production by one of the most developed nations has opened a new discussion on the lack of biomass for energy production. The sources of biomass in India are even more meagre and are in perpetual competition with the food grains. The shrinking per capita land area coupled with increasing demand for energy has generated enough heat in the political, social and scientific circles. The ever-increasing inflation rate is mainly attributed to the increasing energy costs, mostly in the form of transport fuel.

Table 1. Estimated requirement of different classes of seed-cane

Seed class*	Projected requirement (t)	Estimated area required for production (ha)	Estimated productivity (t/ha)
Seed required by farmers (certified seed)	4.50 million	75,000	60
Foundation seed	4.50 lakh	7500	60
Breeder seed	45,000	750	60
Nucleus seed	4500	90	50

*All estimations are based on the following considerations: Area under sugarcane: 4.30 mha. Area under plant crop: 50% or 2.15 mha. Seed replacement rate: Once in 3 years, i.e. 1/3 of 2.15 mha or 0.72 mha. Seed rate: 06 t/ha.

Considering the importance of bio-fuels, every country is setting some target for its production and use in the coming years. For example, by 2020, China aims to use 10 mt of bio-ethanol and 2 mt of bio-diesel, replacing 10 mt a year of petroleum-based fuel. Further, ethanol now makes up more than 20% of Brazil's transport fuel market, whereas the use of alternative fuels in the rest of the world is just 1%. India had around 35 mha of wasteland that can be used to cultivate bio-fuel-producing plants like *Jatropa*. India may consult Brazil over bio-fuel production for fuel sustainability, but Prime Minister Manmohan Singh has made it clear that our country, facing a food shortage, will not copy the South American nation to make ethanol from edible plants. However, due to scarce water and other inputs, bringing of additional wastelands under cultivation is a scientific and developmental challenge.

India's best biomass-producing crop, sugarcane, is suffering dual pressure from the sugar industry and ethanol industry. The other multi-purpose (sweetener, energy, cattle feed, etc.) crops like sugarbeet, sweet sorghum and maize have to compete with grain crops. Thus, we have to formulate strategies to save all the biomass that is produced. One such strategy in sugarcane is to manage seed-cane in a precise manner. This refers to the high seed-cane requirement (general recommendation of 60 q ha^{-1}) of sugarcane, irrespective of the variety. It is observed that there is a large variability in single cane weight among the commercially grown varieties (Figure 1). According to the recommended practices, every running metre length of the crop sown should have 12 buds, which results in four main or mother shoots, thus giving rise to four clumps per running metre. With this simple recommendation, there may be two ways to reduce the seed-cane requirements (Table 1). First, by decreasing the number of buds sown

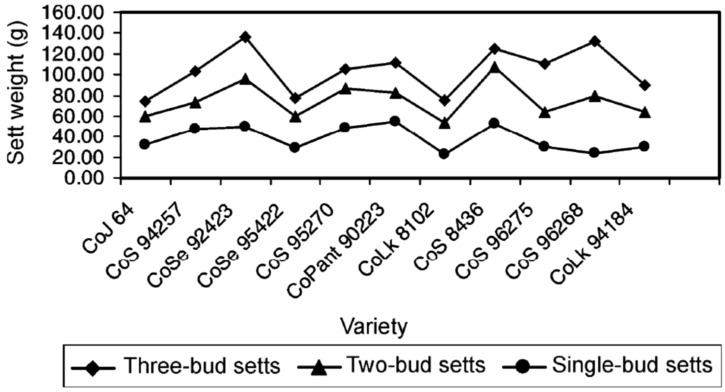

Figure 1. Variability in weight of cane setts of different varieties.

per unit area, i.e. by planting two-bud or single-bud setts; second, by precision use of three-bud setts, i.e. by planting counted number of pre-weighed setts. The first option is recommended when assured irrigation is available, as two- and single-bud setts lose their moisture earlier than three-bud setts. Nursery of single-bud setts, i.e. polybags raised or STP can also be used when irrigation is assured.

The second method, that is, using three-bud but pre-weighed setts, is an option which in coming years can help in saving the precious biomass along with maintaining the quality of marketed seed-cane. The provisions of the Seed Act, 1966, and the proposed Seed's Bill, 2004, will require packaging of seed-cane as well. As of now, the seed-cane is transported and sold without proper labelling and packaging along with the inert material. Due to inert material, including green leaves, trash, internodes without effective buds, etc. the cost of transportation increases and a lot of biomass is wasted. Once the packaging of seed-cane is promoted and adopted, these wastages can be regulated to a great extent. Seed-cane packaging, being a novel concept for the seed industry, raises several doubts about its economics and profitability. But, the vast acreage of sugarcane in India (4.2 mha in 2005–06) and the requirement of seed-cane for this area are in favour of seed-cane industry. Here, a model conceptual framework for seed-cane packaging is presented, which indicates that the concept is economically sound and can save energy as well. Once adopted *in toto*, it will be a multi-million industry.

The flow chart for cane-seed processing and packaging is presented in Figure 2. It is evident from the flow chart that the unit operations involved in seed-cane processing are:

- Harvesting of whole seed-cane stalks along with trash and loading into transport vehicles.
- Transportation of whole cane stalks with trash to processing unit.
- Cleaning of whole seed-cane stalks by removing the trash.
- Cutting of 35 cm long (3–4 bud) setts and chopping of trash to be used during packaging.
- Selection of good-quality setts through visual observation by removing the diseased and damaged setts.
- Treatment of setts by soaking into a biological culture-plus-micronutrient solution for a predetermined time.
- Weighing, packaging and labelling along with storage of packed seeds.

Table 2. Comparative economics of conventional and conceptual system of seed-cane handling

Particulars	Conventional system	Conceptual system without using detrasher and sett-cutting machine	Conceptual system with detrasher and sett-cutting machine
Cost of harvesting and loading (Rs/t)	208.33	208.33	208.33
Cost of transportation from field to farmer's field (Rs/t/100 km)	878.95	–	–
Cost of transportation from field to processing unit (Rs/t)	–	108.27	108.27
Cost of unloading of whole cane stalks along with trash at destination field (Rs/t)	83.33	–	–
Cost of detrashing and sett-cutting (Rs/t)	400 (at end-user)	400 (at SPU**)	72.12 (at SPU)
Cost of sett treatment (Rs/t)	140	73.33	73.33
Cost of packaging (Rs/t)	–	433.33	433.33
Cost of transportation from processing unit to destination field (Rs/t/100 km)	–	421.90	421.90
Cost of unloading of processed seed setts at destination field (Rs/t)	–	33.33	33.33
Total cost of seed handling (Rs/t)*	1710.61	1678.49	1346.55

*Cost of seed-cane handling, excluding the cost of raw seed materials. **Seed Processing Unit.

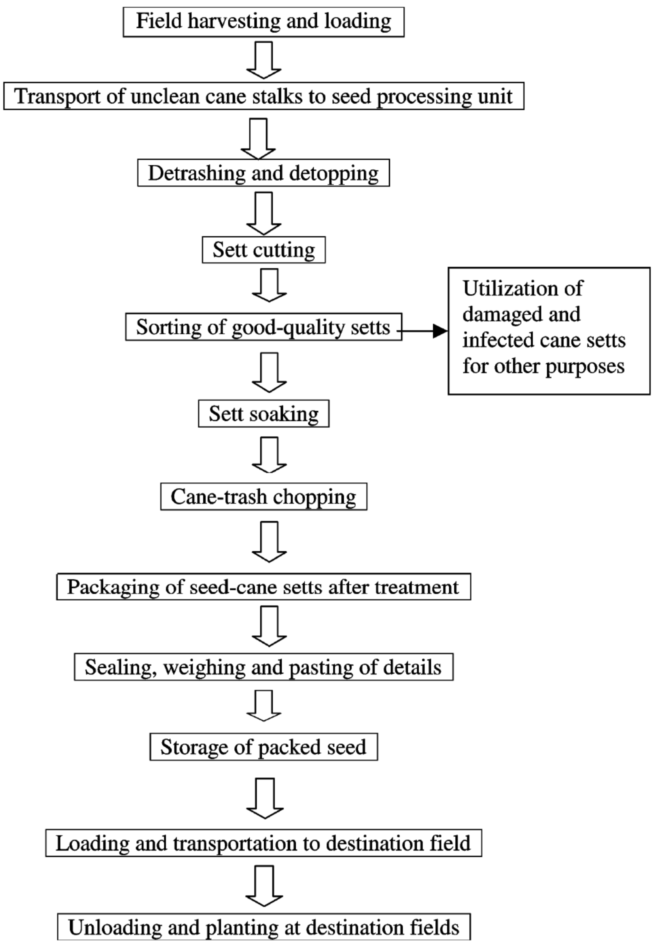

Figure 2. Activity flow chart of conceptual seed-cane processing unit.

In order to perform the above unit operations involved in seed-cane processing, a sugarcane seed-processing centre is needed. The conceptual layout of a sugarcane seed-processing complex is presented in Figure 3.

There is need to assess the comparative economics of seed-cane setts preparation under the conventional and suggested system of seed-cane handling. The cost of handling of whole seed-cane stalks, for preparation of setts under conventional as well as conceptual system, is presented in Table 2. The cost of handling of field-harvested seed-cane stalks has been compared up to the stage of sett preparation for planting in the field. The cost of handling of seed-cane presented in Table 2 does not include the cost of raw seed material (harvested whole cane-seed stalks). The parameters used in the analysis of cost components are presented in Table 3. These parameters are either based on the actual performance data or taken from Bureau of Indian Standards (IS: 9164-1979) for estimation of cost of farm-machinery operations. The increase in the cost of seed-cane setts can be reduced by means of mechanical intervention. Harvesting of whole cane stalks will be performed manually using knives. The possibility of use of whole-cane sugarcane cutter-cum-windrower could be explored for cutting of whole cane stalks. The cut canes along with trash are loaded into the transporting tractor-operated self-unloading trailers. With the help of these trailers cut cane stalks are supplied to the cane-processing unit. The trailers are of self-tipping type. The cane stalks will be cleaned manually by removing green and dry trash. Use of machine for detrashing of cane could be explored. The sett-cutting machine will be used for cutting of 35 cm-long setts. Use of detrasher and sett-cutting machine will give an output

Table 3. Selected parameters for analysis of cost components

Average purchase price of tractor (Rs)	350,000
Average purchase price of truck (Rs)	850,000
Average purchase price of tipping trailer (Rs)	80,000
Cost of two sets of detrashing and sett-cutting machine (Rs)	80,000
Cost of prime mover (electric motor; Rs)	20,000
Economic life of truck, tractor, trailer and electric motor (years)	10
Economic life of detrashing and sett-cutting machine (years)	6
Number of working days for the equipments (detrashing, sett cutting and electric motor) in a season	90
Working hours per day for farm equipment	8
Working days of truck, tractor and trailer per year	150
Rate of interest on investment (decimal)	0.12
Insurance factor (percentage of average purchase price)	2.00
Shelter charge factor (percentage of average purchase price)	1.50
Wages of labour (Rs/man-days)	100
Salvage value factor for agriculture equipment (decimal)	0.05
Wages of tractor and truck operator (Rs/man-days)	200
Wages of truck attendant (Rs/man-days)	100
Price of diesel fuel (Rs/l)	34
Price of oil (Rs/l)	133
R&M factor of truck, tractor, trailer, detrasher, sett-cutting machine and electric motor (percentage of purchase price/100 h)	1.0
Expected actual operation of tractor–trailer for transportation of whole cane from field to processing unit (h/day)	4
Average fuel consumption of tractor (l/km)	0.20
Average fuel consumption of truck (l/km)	0.30
Average oil consumption of tractor and truck	2.5% of fuel
Expected travel of tractor–trailer for transportation of whole cane from field to processing unit (km/day)	100
Carrying capacity of truck for field-harvested whole cane with trash (t)	6.0
Carrying capacity of truck of packed seed (t)	10.0
Output of manual field harvesting and loading of cane with trash (t/man-days)	0.6
Output of manual unloading of whole cane stalks with trash (t/man-days)	1.5
Output of manual unloading of packed seed-cane (t/man-days)	3.0
Output of manual detrashing (t/man-days)	1.0
Output of manual-sett cutting (t/man-days)	0.33
Sorting and sett treatment (labour cost; t/man-days)	1.0
Cost of packets (Rs per packet of 50 kg capacity)	20
Trash percentage in the field-harvested cane	20
Average electricity consumption of detrashing and sett-cutting machine (unit/days)	30
Electricity charge (Rs/unit)	5.0
Cost of biological culture and micronutrient solution (Rs/t)	40
Labour employed with detrashing and sett-cutting machine at SPU	6
Labour employed in sorting of setts and sett treatment at SPU	5
Labour employed in packaging at SPU	5
Labour employed in loading of packed seed setts at SPU	2

of about 40,000 seed setts (5–6 t) in 3 h. Using one set of equipment enables the operator to prepare approximately 15 t of seed-cane setts per day in 8 h of operation. Cut setts are collected and sorted for healthy and non-healthy ones. The visibly good seed setts are dropped into a container with biological and micronutrient solution for treatment for a predetermined period. These treated seed-cane setts are packed in cartons of sufficient strength. After each layer of seed sett, a layer of chopped trash will be kept. It will prevent any bud damage during handling and transportation. Before sealing the packed carton, a fumigant may also be used. After sealing, the weight of the packet is recorded and a sticker is pasted over them mentioning details of seed such as variety, weight, date of packaging, etc. Packed seed-cane is loaded into transport vehicles for transportation to the farmers' field.

The conceptual mechanical interventions discussed while processing seed-cane could be explored in the beginning (to start with) either directly by adopting the available equipment or by modifying them according to the need, such as removal of trash using detrasher and sett cutting using sett-cutting machine. Transportation of field-harvested cane stalks can be mechanized using tractor-operated tipping trailers (only loading to be done manually). In the beginning, handling of seed-cane setts during treatment and packaging could be done manually. Once the process is established, this operation can also be mechanized by designing and developing suitable conveyors. It is obvious that the adoption of the suggested system of

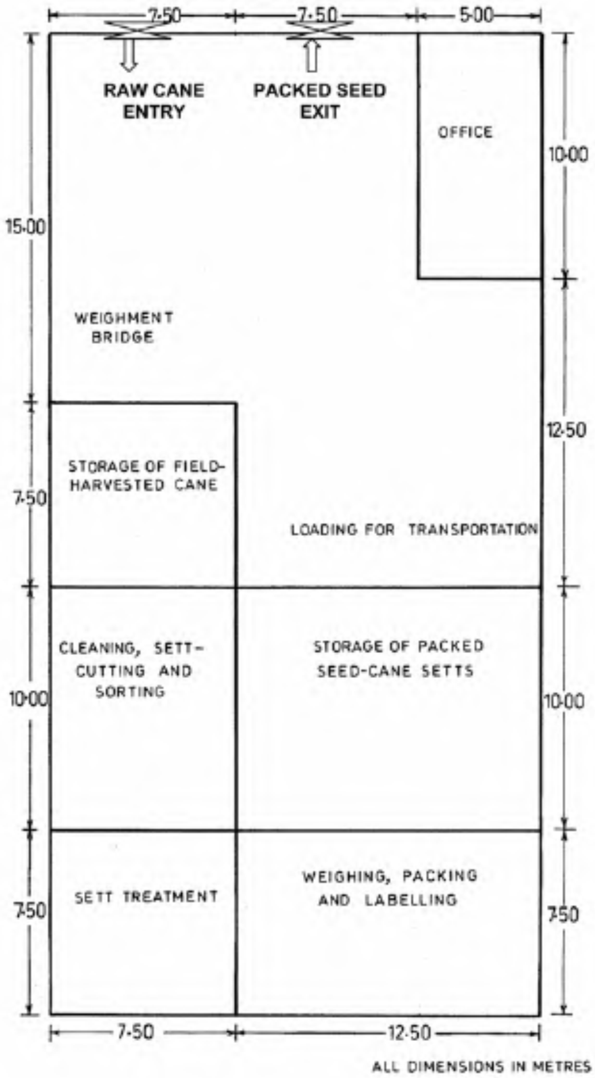

Figure 3. Conceptual layout of cane-seed processing complex (capacity 15 t/d).

seed-cane handling for preparation of processed and packed seed-cane setts will open a new vista of research. There will be need to conduct research to confirm the superiority of this system under diverse situations of seed-cane sett preparation. It will also be needed to assess the maximum life of processed and packed seed setts for specific varieties and agro-climatic conditions. Accordingly, storage life of packed seed-cane setts has to be mentioned on the labels and it may vary with the variety.

The comparative economics of seed-cane handling of the conceptual system and conventional system indicates that the handling of raw seed-cane by processing and packaging under the conceptual system is economically viable. The concept on the one hand makes the seed-cane legally viable and on the other, it adds value and quality to it. The marketing value and demand of such seed-cane need to be worked out through surveys and test-marketing. The potential of the processed seed-cane in providing better germination and checking disease transmission is well-known, but its acceptance among farmers will be established once the technology reaches the farmer's field.

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Nutritional security: a missing link in climate change debates

Manoj-Kumar and A. K. Patra

Climate change is no longer a distant scientific prognosis; it has rather become a reality established beyond doubts. Rise in atmospheric concentration of carbon dioxide (CO_2) and the accompanying increase in air temperature on the earth's surface have been the two most striking manifestations of global climate change in recent decades. Both of these changing climatic variables are closely associated with the growth and productivity of food crops, particularly C_3 crops (e.g. wheat and rice), which constitute about 95% of the agriculturally important crops worldwide. Since atmospheric CO_2 is the sole source of carbon for plants, variations in its concentration have obvious implications for plant growth. The best growth and yield performances of C_3 crops are observed at around 1000–1200 μmol mol^{-1} CO_2 concentration. As the current atmospheric concentration of CO_2 (385 μmol mol^{-1}) is in short supply to saturate the growth and yield responses of the C_3 crops, any further increase in CO_2 concentration is expected to increase the productivity of these crops[1]. Although increased crop yield with rising CO_2 is now a well-established global phenomenon, the effects of increasing temperature may be highly region-specific. The temperature rise in temperate and polar regions, where crop