



INDOOR PLANTS WORK

IMPROVE YOUR
BOTTOM-LINE

Science shows that indoor plants:

- > Reduce indoor air pollution
- > Reduce workplace illness
- > Reduce sick-leave absences
- > Reduce stress and negativity
- > Do not create unhealthy mould problems
- > Raise performance & productivity
- > Improve job satisfaction
- > Enhance business image with potential clients
- > Improve school performance & patient wellbeing
- > Contribute to meeting at least 75% of Indoor Environmental Quality (IEQ) criteria

Current research at UTS aims to establish optimum conditions for indoor plants to be used in routine installations to reduce building energy costs for sustainable urban living.



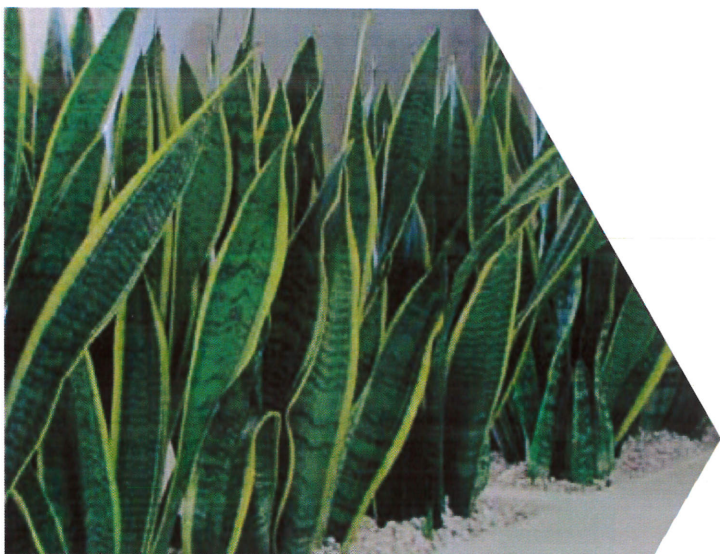
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Indoor plants improve indoor air quality (IAQ)

Indoor air pollution can induce Sick-Building-Syndrome (SBS), with symptoms of coughing, wheezing, headaches, sore eyes, nose, or throat, loss of concentration and nausea^(1,2). City building air-conditioners normally filter out dust (particulates) from incoming air, but don't remove gaseous pollutants.

Indoor plants reduce all types of urban air pollution⁽³⁻¹⁰⁾ (90% of which comes from fossil fuel combustion):

- > Nitrogen and sulfur oxides
- > Carbon dioxide (CO₂) & carbon monoxide (CO)
- > Air toxics (ie volatile organic compounds 'VOCs')
- > Fine particulate matter (PM10/2.5)
- > Ozone

And indoor air is always more polluted than outdoors, even in CBD — why? As polluted outdoor air enters it meets up with more pollutants from indoor sources:

More VOCs emitted from plastics/synthetics, in furniture/furnishings/paints/solvents/computers, etc.

UTS laboratory research (17 species/varieties) shows indoor plants⁽¹¹⁻¹⁴⁾:

- > Have strong capacity to remove VOCs; and
- > If concentrations rise, so do rates of removal
- > All species are about equally effective — main removal agents are normal root-zone bacteria; plant nourishes & regulates its microorganisms (symbiosis)
- > Hydroculture plants work also (just a bit slower to get started)
- > VOCs are removed day and night (24/7)
- > Absorbed VOCs don't accumulate — broken down to CO₂ and water

UTS office study found

- > 3 to 6 plants / office kept VOC levels below 100 parts per billion (ppb) — regarded as negligible health risk (Aust. recommended total VOC max. is 500 ppb)

Overseas laboratory studies

(> 200 species)

- > All show VOC removal

It looks like any normal indoor species will remove VOCs

> More CO₂ from us breathing

(Aust. recommended indoor CO₂ max. is 1,000 parts per million (ppm); global CO₂ levels now ~400 ppm and rising)

Any green shoot, with adequate light, will remove CO₂ (photosynthesis/sugar manufacture) and release equal amounts of O₂ — two-way refreshment! But every species, including 'indoor' plants, has its idiosyncrasies of photosynthetic function as well as appearance, so, to optimise CO₂ reduction:

- > Place species according to recognised shade tolerance
- > The more foliage the better; & targeted plant lighting could help^(16, 17)
- > UTS office study⁽¹⁵⁾ found CO₂ reductions of 10% or more
- > Preliminary UTS laboratory study⁽¹³⁾ found CO₂ uptake was a bit faster in hydroculture plants than in pot-mix (probably because of fewer non-green tissues, inc. roots & root-zone microorganisms, which all respire).

INDOOR
PLANTS
A Bonus for Business!

Cleaner air enables clearer thinking

A European study by engineers/physicists found a 1% reduction in dissatisfaction with IAQ resulted in a 10% increase in productivity!⁽¹⁸⁾ — that means: Indoor plants repay more than the cost of their keep!

Office plants promote occupant health and wellbeing

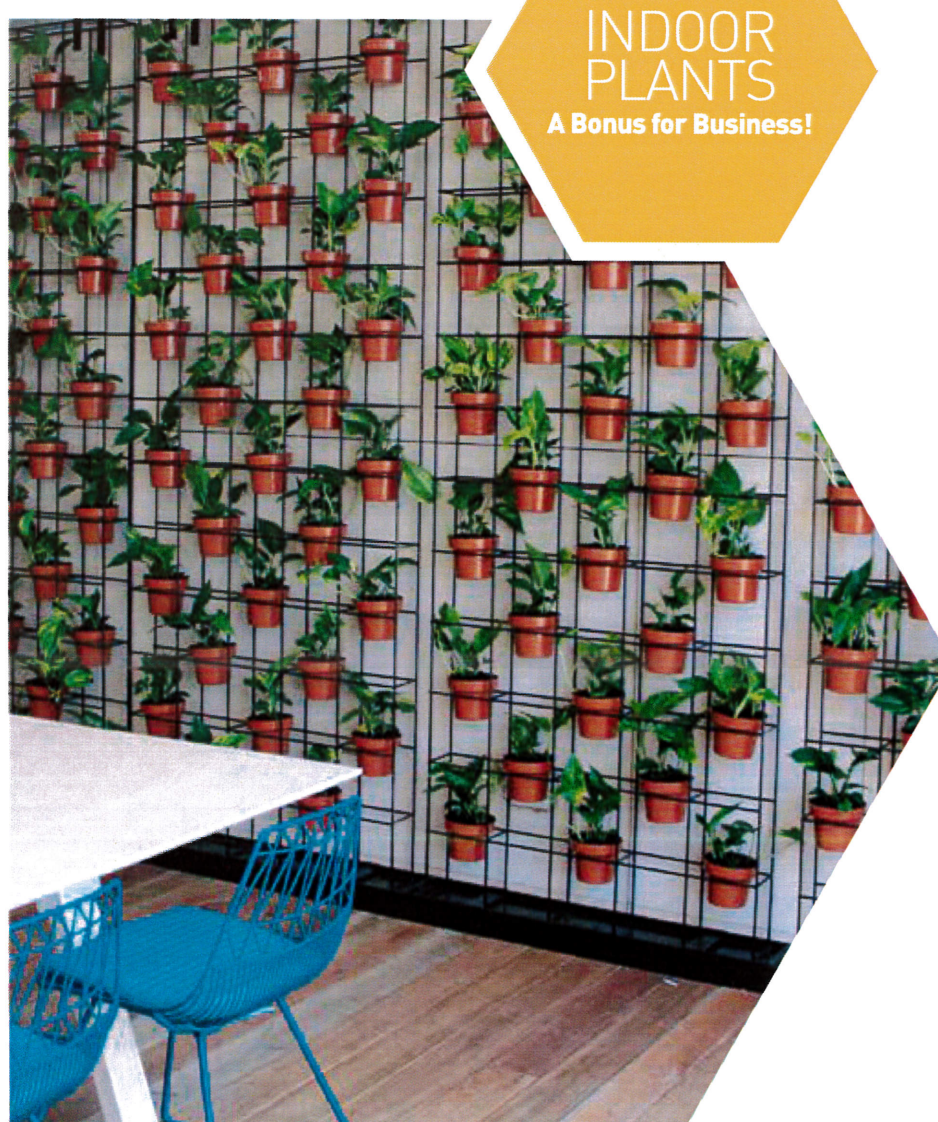
Medical research shows workplace stress reduces productivity and performance, & leads to illness; stress-related illness is a widespread urban health concern; and staff illness & sick-leave absences are used as direct indicators and measures of lost productivity⁽¹⁹⁻²¹⁾.

International research shows indoor plant presence reduces illness and absences⁽²²⁻²⁴⁾:

- > Sick-leave — from 20 to >60%
- > Coughing & wheezing — 35%
- > Dry eyes, nose, throat — 20%
- > Perceptions of pain — 25%

And reduces feelings of stress and negativity⁽²⁵⁻²⁷⁾:

- > Lowered tension levels, using EEG, EMG, blood pressure readings
- > Survey questionnaires probing stress and/or negativity



> **UTS office study** (55 staff; single offices) recorded average scores of reductions in stress and negative mood feelings of over 40%

Indoor plant presence increases productivity, performance, job satisfaction, by >10%, measured by⁽²⁸⁻³¹⁾:

- > Faster times to complete computer tasks
- > Creative task performance
- > Sorting and editing tasks
- > Attention capacity
- > Job satisfaction (on all 10 criteria tested)
- > Promotes good office relationships

Indoor plant presence improves business image⁽³²⁻³⁶⁾

Surveys show workplace plants give perception that the company is:

- > Trustworthy
- > Warm and welcoming
- > Stable and balanced
- > Well-run
- > Patient and caring
- > Concerned for staff wellbeing
- > Not mean — spends money on added beauty and calmness
- > Provide a healthier, cleaner atmosphere

Indoor plants also aid school performance^(22, 36, 37)

- > Primary school absences reduced 23%
- > **UTS-IPA study** — (Qld) (4 pots/classroom) Mathematics, science & spelling scores improved 11–12% compared with no-plant rooms
- > **Portuguese study** — 6 hanging-plant baskets/classroom reduced: CO2 by 45%; Total VOCs –27%; PM10 –30%, compared with no-plant rooms

And aid patients in healthcare facilities⁽³⁸⁻⁴¹⁾

- > Hospital — recovery from surgery — fewer pain-killers & other medications; fewer complaints
- > In rehabilitation care — more positive outlook
- > Residential care for dementia — stimulated awareness; more positive emotions(ref)

Think green zones, desk-tops, file-top hedges; vertical gardens, lift areas, foyers, etc. – there’s a living-green contributor to performance and wellbeing in any workplace building.

Q. How do indoor plants reduce stress and increase productivity?

Environmental-psychologists and human-ecologists agree that⁽⁴⁵⁻⁵¹⁾:

- > Humans developed in a green leafy landscape, and we’re therefore hard-wired for the feeling of ‘green-is-the-good-place-to-be’ (think real-estate prices as a reality check!).
- > As a consequence of this ‘native landscape of origin’, urban populations suffer ‘green deprivation’ compared with our ancestors (again, think real-estate & ‘get-away’ camping weekends):
 - In 1800, only 3% of global population lived in urban areas
 - Now it’s > 50%, and rising
 - It’s about 80% in developed countries, where we urbanites spend 90% of time indoors

- Where brief glimpses of living greenery in our immediate environment (eg. on desk or thereabouts) provide us with unconscious feelings of calm and a wider space, even if we don’t notice the plant presence
- This momentarily relaxes us, resetting our ‘attention-button’, & preventing development of attention fatigue — so we work better — for longer — giving better performance — and we feel happier about it all too.



INDOOR PLANTS
 A win-win-win for people, profits, planet
 The triple-bottom-line

Indoor plants contribute to at least 75% of Indoor Environmental Quality (IEQ) Criteria*

IEQ criterion	Indoor plants
Air pollution mitigation	Reduce all types of UAP ⁺⁺ ; healthy plants do not contribute to unhealthy mould spore concentrations ⁺⁺⁽⁴²⁾
Low Emitting Materials	Absorb toxic emissions — VOCs etc.**
Ventilation effectiveness	Increase effectiveness; remove CO ₂ /replace with O ₂ ⁺⁺ ; & lower indoor particulate levels ⁽⁴³⁾
Lighting	OK for Plants? — OK for staff also ⁺⁺
Noise	Absorb & buffer noise ⁺⁽⁴⁴⁾
Views	Add aesthetics & calming greenery; lower stress ⁺⁺
Thermal comfort	Not directly influenced — but tend to stabilise humidity in human comfort zone, so could have unquantified effects here ⁻
Systems controllability	Not directly influenced — but stabilisation of temperature and humidity (as well as enhanced CO ₂ reduction) could lower air-con. energy consumption

*Criteria list: NSW Gov. Workplace Guidelines, 2010. ⁻Overseas studies; ⁺⁺O/S & UTS studies