



PLANTS AT WORK

IMPROVE YOUR BOTTOM-LINE
PROFIT-PEOPLE-PLANET!

Research shows that indoor plants

- > Improve productivity and performance
- > Reduce indoor air pollution
- > Reduce sick-leave
- > Lower stress and negative feelings
- > Improve business image with potential clients
- > Contribute to fulfilling at least 75% of Indoor Environmental Quality (IEQ) Criteria

INDOOR PLANTS REDUCE ALL TYPES OF URBAN AIR POLLUTION

And, indoor air is almost always more polluted than outdoors. In particular, indoor air generally has more:

- > **Volatile organic compounds (VOCs)**
Emitting from plastics/synthetics, in furniture, fittings, computers, printers and more, cause loss of concentration, headaches, eye, nose and throat problems.
- > **CO₂ (us breathing)**
Causes drowsiness, 'heavy-head', lowered concentration

Overseas findings¹⁻⁴ indoor plants can reduce:

- > **Nitrogen and sulfur oxides**
- > **Air toxics**
(ie, volatile organic compounds, VOCs) eg BTEX (Benzene, Toluene, Ethylbenzene, Xylene); & PAHs
- > **Particulates**
(eg PM10/2.5)
- > **Ozone**

Our UTS findings⁵⁻⁹ indoor plants can reduce:

- > **VOCs**
By over 80% to below 100 ppb (Aust. Office Max. 500 ppb)
- > If VOC loads go up, so do removal rates
- > All plant species equally effective (the process depends on symbiosis with normal potting-mix bacteria)
- > Works day and night (24/7)
- > And 20 cm pots are as effective as 30 cm pots (ie abundant capacity for VOC removal)
- > **CO²**
> By 10-25%
> Exchanged for equal amount of O₂ two-way refreshment!
> The more foliage the better
> Optimise CO₂ reduction by placing plants according to their recommended shade tolerances
- > **CO (carbon monoxide)**
> By up to 90%



Indoor plants can be deployed to reduce building A/C energy costs, for sustainable urban living.

PLANTS AT WORK DIRECTLY INCREASE PRODUCTIVITY AND PERFORMANCE

International research shows indoor plants provide multiple benefits to building occupants:

Reduced illness symptoms¹⁰⁻¹⁴:

- > Sick leave in office staff
- > Sick-leave in school children
- > Coughing, wheezing
- > Sore eyes, nose, throat
- > Pain perception
- > Lower blood pressure
- > Reduce 'attention fatigue'
- > Intentions to quit (save on training new staff)

Improved performance scores on¹⁵⁻¹⁷:

- > Sorting tasks
- > Creative thinking tests
- > Examinations
- > Computer task productivity 12%
- > Attentiveness - 27%

And a productivity improvement of less than just 1% more than repays the cost of the indoor plants.

INDOOR PLANTS GREATLY REDUCE STAFF STRESS – PROMOTING PRODUCTIVITY & PERFORMANCE

Medical research shows

- > Stress reduces productivity and performance, and leads to illness;
- > Stress-related illness is a widespread urban health concern^{18,19}.

Our UTS study shows large stress reductions with indoor plants⁶

- > First such study to use standard international psychological surveys
- > 40 respondents

Results

Staff with one or more plants in their offices showed reductions in*:

- | | |
|----------------------|------|
| > Anxiety | -37% |
| > Anger | -44% |
| > Depression | -58% |
| > Fatigue | -38% |
| > Confusion | -30% |
| > Overall negativity | -65% |
| > Overall stress | -50% |

*No-Plant (Control) group showed the opposite trend -

- > Increased negativity +20-40%

Indoor plants directly raise spirits- Increasing productivity and performance.

INDOOR PLANTS IMPROVE BUSINESS IMAGE WITH POTENTIAL CLIENTS/CUSTOMERS

Surveys show^{19,20} – Plants in the foyer and office spaces give the perception that the company is:

- > Trustworthy
- > Warm and welcoming
- > Stable and balanced
- > Well-run
- > Patient and caring
- > Concerned for staff welfare
- > Comfortable to work with
- > Prepared to spend money on added beauty
- > Not mean
- > Providing a healthier, cleaner atmosphere

Cleaner air is healthier air, and leads to clearer thinking!

PLANTS ALSO IMPROVE STAFF JOB SATISFACTION

Surveys show^{12,21}

- > Improved scores on full range of job satisfaction criteria
- > Plants on or near desk preferred to leafy window views, Why?
- > They give more immediate, living, green aesthetics 'biophilia'!

And CONTRIBUTE TO AT LEAST 75% OF INDOOR ENVIRONMENTAL QUALITY (IEQ) CRITERIA

IEQ criterion	Indoor plants
Air pollution mitigation*	Reduce all types of UAP**
Low Emitting Materials*	Absorb toxic emissions - VOCs etc.**
Ventilation effectiveness*	Increase effectiveness - remove CO ₂ /add O ₂ **
Lighting*	OK for Plants? - OK for staff also?*
Noise*	Absorb & buffer noise*
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 could lower air-con. energy consumption

*Criteria list - NSW Government - Workplace Guidelines, 2010.

+Overseas studies; ** O/S & UTS studies

Greening the great indoors for productivity and performance

- > Think desk-tops; file-top 'hedges'; green zones; nooks; spaces; walls, or vertical gardens.
- > There's a 'living green' contributor to productivity & workplace sustainability in every building situation.

Plants at work improve your triple-bottom line.





Selected bibliography

1. Coward M, Ross D, Coward S et al., 1996, Pilot Study to Assess the Impact of Green Plants on NO₂ Levels in Homes, Building Research Establishment Note N154/96, Watford, UK.
2. Kim KJ, Kil MJ, Song JS et al., 2008, Efficiency of volatile formaldehyde removal by indoor plants, *J. American Soc. Hort. Science*, 133, 1-6.
3. Lee J-H & Sim W-K, 1999, Biological absorption of SO₂ by Korean native indoor species, In: Burchett et al. (eds) *Towards a New Millennium in People-Plant Relationships, Contributions from International People-Plant Symposium, UTS, Syd.*, 101-108.
4. Lohr VI & Pearson-Mims CH, 1996, Particulate matter accumulation on horizontal surfaces in interiors: influence of foliage plants, *Atmospheric Environment*, 30, 2565-8.
5. Burchett MD, Torpy F & Brennan J, 2009, *Towards Improving Indoor Air Quality With Potted -Plants A Multifactorial Investigation*, Fin. Rep. to Hort. Aust. Ltd.
6. Burchett MD, Torpy F & Brennan J, 2010, *Greening the Great Indoors for Human health and wellbeing*, Fin. Rep. to Hort. Aust. Ltd.
7. Orwell, R et al., 2006, The potted-plant microcosm substantially reduces indoor air VOC pollution: II. Lab. study, *Water, Air & Soil Pollut.*, 177, 59-80.
8. Tarran J, Torpy F & Burchett M, 2007, Use of living pot-plants to cleanse indoor air - research review, *Proc. 6th Internat. Conf. IAQV & Energy Conservation, - Sustainable Built Environment, Sendai, Japan, Oct., Vol III*, pp 249-256.
9. Wood RA, Burchett MD, Alquezar A et al., 2006, The potted-plant microcosm substantially reduces indoor air VOC pollution: I. Office study, *Water, Air & Soil Pollut.*, 175, 163-180.
10. Fjeld T, 2002, Effects of plants and artificial daylight on well-being and health of office workers, school children and health-care personnel, *Proc. Internat. Plants for People Symp., Floriade, Amsterdam, NL*.
11. Fjeld T et al., 1998, Effect of indoor foliage plants on health and discomfort symptoms among office workers, *Indoor and Built Environment*, 7, 4, 204-209.
12. Lohr VI et al., 1996, Interior plants may improve worker productivity and reduce stress in a windowless environment, *Environ. Hort.*, 14:2, 97-100.
13. Lohr VI & Pearson-Mims CH, 2000, Physical discomfort may be reduced in the presence of interior plants, *HortTechnology* 10:1, 53-58.
14. Park S-H et al., 2002, Pain tolerance effects of ornamental plants in a simulated hospital patient room *Acta Horticulturae* 639, 50-52.
15. Clements-Croome DJ, 2008, Work performance, productivity and indoor air, *Scandinavian J. Work, Environment & Health (Supplement)*, 34, 4, 69-78.
16. Han K-T, 2008, Influence of limitedly visible leafy indoor plants on the psychology, behavior, and health of students at a junior high school in Taiwan, *Environ. & Behav.*, doi:10.1177/0013916508314476,.
17. Bergs J, 2002, Effect of healthy workplaces on well-being and productivity of office workers *Proc. Internat. Plants for People Symp., Floriade, Amsterdam, NL*
18. Kopp MS et al., 2007, Work stress and mental health in a changing society, *The European Journal of Public Health*, 18, 3, 238-244.
19. Dijkstra K et al., 2008, Stress-reducing effects of indoor plants in built healthcare environment: Mediating role of perceived attractiveness, *Prevent. Med.* 47:3, 279-283.
20. Aitken JR and Palmer RD, 1989, The use of plants to promote warmth and caring in a business environment, *Proc. 11th Ann.Meet. Ame.rCulture Assocn.*, St Luis, MO.
21. Dravigne A et al., 2008, The effect of live plants and window views of green spaces on employee perceptions of job satisfaction, *Hortscience* 43, 1, 183-187.

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