

How to Grow Fresh Air

How to Grow Fresh Air

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and
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 juggernaut

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We dedicate this book to our children and grandchildren who, unknowingly, are sacrificing their health by living in Indian cities that have unacceptable air quality.

We feel responsible and guilty. For not letting them play out in the open. And to know that they will miss their chance at becoming a Sachin Tendulkar or a Sania Mirza!

We also dedicate this book to the future occupants of smart cities, who wish to achieve their full potential.

*'Some old-fashioned things like fresh air and
sunshine are hard to beat.'*

Laura Ingalls Wilder

Contents

<i>Foreword by Suresh Prabhu</i>	xi
<i>Introduction</i>	1

Part I: What's in Our Air?

1. Air – The Silent Killer	31
2. Indoor Air is Just as Toxic as Outside Air	69

Part II: 4 Steps to Purify the Air in Your Home

3. Step 1: Declutter and Clean	91
4. Step 2: Invest in a Good Air Purifier	109
5. Step 3: Sealing and Ventilation	129
6. Step 4: Indoor Plants that Give Us Fresh Air	145

Contents

Part III: Protect and Participate

7. Diet and Exercise to Improve Lung Function	165
8. What We Can Do as a Community to Clean Our Air	183
<i>A Note on the Authors</i>	209
<i>A Note on the Climate Reality Project</i>	213
<i>A Note on the Paharpur Business Centre</i>	217
<i>A Note on Breathe Easy</i>	221
<i>Acknowledgements</i>	223
<i>References</i>	225

Foreword

How to Grow Fresh Air, authored by Kamal Meattle and Barun Aggarwal, is really informative – one will get answers to all questions about air pollution and its effects, and learn about ways to mitigate the same.

In this book, the authors have mapped the environmental phenomenon in the country and the need to develop optimal policies and technologies for creating sustainable, safe and secure air. The book chronicles how environmental education can contribute to urban sustainability. The authors have also analysed the sources and inspirations of green thought and given a voice to those furthering the

Foreword

development of a long-term healthy ecosystem. They have attempted to keep the text simple and limit the explanation to basic concepts so that the content can be understood by both beginners and professionals.

I am of the opinion that smart cities should have a smart environment. This book discusses a range of measures to mitigate air pollution and create a smart environment for a healthy and breathable city. I have always been very supportive of ideas that promote an ecologically stable environment and have encouraged innovations that use natural resources to create provisions for future generations.

Today, human activity is increasing at a pace that has never been seen in history. Developing countries are witnessing a faster rate of population growth, urbanization and economic development as compared to developed countries. Consequently, developing countries have had to deal with more serious environmental problems, including air pollution and other related issues, than developed

Foreword

countries. During my tenure in the Ministry of Environment and Forests, we had introduced fruitful schemes to reduce pollution in India, which included implementing various policies and legislations to promote clean air. The nation needs more initiatives like Swacch Bharat Abhiyan to further curb air degradation.

I commend the authors for writing this book which can be of great help to pursue the dream of 'Clean India'. I wish them all the best in their efforts to increase environmental awareness and support an ecologically balanced earth.

Suresh Prabhu
Minister of Commerce & Industry and
Civil Aviation

Introduction

A mad gamble

One morning, around twenty-six years ago, I woke up and couldn't breathe. I should have seen it coming, but I didn't.

The problem began with an unsuspecting cough followed by allergies. I turned to cough medicines, anti-allergy puffs and inhalers. But soon I realized that this sudden inability to breathe was different from a regular allergy. It was as if someone was choking me.

I was terrified. I rushed to my doctor immediately. After several tests, his diagnosis was grim. He told me that my lung capacity had dropped to 70 per cent. In other words, the 4 to 6 litres of air my lungs could take in had now whittled down to just a little more than 3 to 4

How to Grow Fresh Air

litres. I knew that was reason enough to panic, because our lungs, like many other organs in our body, are usually built to handle excess. In our day-to-day life, we don't use more than 30 per cent of our lung capacity. But after the diagnosis, the problem became all too real.

I couldn't understand what had gone wrong. I had always been careful. What could have possibly led to a part of my lungs giving up on me?

After several days, my doctor had the answer.

Delhi's air was destroying my lungs, bit by bit.

The main culprit was the high concentration of benzene in the air coming from the five per cent benzene content in petrol, besides other volatile chemical compounds in the lubricating oil added to petrol and emitted by two-stroke engine two-wheelers. Benzene is an organic chemical compound with a sweet smell. A by-product of coal distillation, benzene is toxic and highly flammable. It is used as an industrial solvent in paints, petrol and washing powders, among other substances. In excess, benzene

Introduction

toxicity can cause damage to the central nervous system and can also be carcinogenic.

In the early 1990s, Delhi was a gas chamber of sorts. Those were pre-CNG days. Back then if you visited the capital, you'd find your eyes itching and burning. You could even smell how toxic the air was. The fumes from vehicles and industries had destroyed the air.

My doctor gave me two choices. One, leave the city and move to a cleaner, greener place. Two, stay back in Delhi and fight, albeit at a dangerous personal cost.

I chose the second option. I was forty-eight years old then, and I neither had the will nor the desire to run away to a foreign land and start from scratch. Moreover, leaving the country felt like a betrayal because Delhi was my home. This was where I had built a life for myself, where my friends and family were. This was where I belonged.

I was aware that this was either the bravest or the most foolish thing to do. It was a decision that could change the course of my life. And I was

How to Grow Fresh Air

very cognizant of the fact that it could shorten my life too. But I decided I was not leaving. I chose to stay back in Delhi and find a solution to the air pollution problem and my deteriorating health. It was a mad gamble, because I didn't have the luxury of time. Whatever I had to do I knew I had to do it quickly.

In the days after my diagnosis, I was hard on myself – Kamal, you are a graduate from the Massachusetts Institute of Technology (MIT), USA. You are also a member of the governing board of the Indian Institute of Technology (IIT), New Delhi. You have all the resources at your disposal. If you can't fix this problem, who can? I goaded myself every minute.

At the next board meeting at IIT, I appealed to everyone there. 'You eminent people are all learned senior scientists. I am in deep trouble. You've got to help me.' I explained my predicament to them.

In a matter of days, all the department heads met to discuss the issue. They had some tough questions for me.

Introduction

How big was the air pollution problem?

Was there anyone else thinking about it or researching air purity in the world?

How were they addressing it?

To begin with – was there a way to clean indoor air?

I didn't have the answers. And I needed to find them urgently.

So we recruited graduate students from different institutes, some even from IIT, to help us solve these puzzles. The work began immediately.

As we started digging deeper into the air pollution problem, we kept coming back to the same answer – National Aeronautics and Space Administration (NASA).

NASA was the only research facility in the world that was experimenting with growing fresh air to fuel colonies in other planets like Mars. It was a great lead. Even though we couldn't get any more data on NASA's research because their information was classified, we knew we'd stumbled across an idea worth

How to Grow Fresh Air

exploring. Of course, we weren't setting out to clean ambient or outside air. That would have made our project immeasurably difficult. What we were looking for was a solution to purify the air in our homes and offices, because that's where we spend most of our time.

We began to ask the questions that NASA was tackling.

How *does* one go about growing fresh air – this invisible, omnipotent substance that is responsible for all life on earth?

It was like playing God.

Baffling though the question was, the answer was even more ridiculous. Especially because it was around us the whole time we were scratching our heads.

Plants.

Yes, it was as simple as that.

All of us are familiar with the term 'photosynthesis' from our science textbooks in school. During the day, plants take in carbon dioxide, use the energy in sunlight to convert the carbon dioxide into sugars and release oxygen

Introduction

as a by-product of this process. Of course, there are other nutrients which are required for the process. Plants require nitrogen, which they get from the soil. But simply put, the formula we were so desperately seeking was the one that plants used every day – plants converting carbon dioxide into oxygen. That was the answer to our problem.

Using plants to ‘grow’ fresh air is a simple solution, but it has barely been explored. An idea so obvious, however, it’s been overlooked by all but a very few researchers.

We turned to IIT and The Energy and Resources Institute (TERI) to help us. TERI had also tested Delhi’s air over the course of twelve months, in all seasons, at different levels, indoors and outdoors.

The benzene content in Delhi’s atmosphere had been measured by the Central Pollution Control Board (CPCB) at 45–55 parts per million (ppm). Anything over 10 is carcinogenic! This was about five times the *then* European Union safety standard of 10 ppm. Currently

How to Grow Fresh Air

the standard is 5 micrograms per cubic metre or 0.001568 ppm or 1.568 parts per billion (ppb).

An independent research carried out in the ITO area of Delhi showed a benzene concentration of 139 ppm. This was directly correlated to the number of petrol vehicles in Delhi. There were 3.5 million in 1999 – more than the total number of cars in Mumbai, Chennai and Kolkata put together. You can imagine what we were breathing every day! On the orders of the Supreme Court, petrol with only 1 per cent benzene was made available from November 2000 in the National Capital Territory (NCT) of Delhi. This was 5 per cent earlier.

In 1998, the Supreme Court of India set up the Environment Pollution (Prevention and Control) Authority (EPCA) to consult and advise and implement measures to curb air pollution. On the orders of the Supreme Court and recommendations of this new authority, the city's buses converted to CNG and all pre-1990 autorickshaws were also ordered to switch to this new clean fuel.

Introduction

Later, I filed a public interest litigation (PIL) in the Supreme Court. An order was passed to have separate *premixed 2 per cent 2T oil with petrol dispensers* at pumps. This would ensure that only 2 per cent of 2T oil would be mixed with petrol to serve as fuel supply for two/three-wheelers.

The EPCA asked for this change to be implemented by the oil companies from January 1999. Earlier, 5–10 per cent of normal engine oil, which was generally used, would be added to petrol by the user instead of the 2 per cent dosage of the special 2T oil designed for these two- and three-wheelers. This action by the court reduced the amount of oil being burnt and discharged through the tailpipes of two/three-wheelers.

The swap to CNG had immediate results, with the CPCB report in 2003 showing that air pollution in Delhi had significantly reduced. This was good news, except I had already been hit by the ill effects of air pollution.

In 1991, our fledgling team started the

How to Grow Fresh Air

Paharpur Business Centre (PBC), to begin testing and researching fresh air solutions. After many hits and misses, we found an answer. There were three common and easily available house plants that could clean the air; including removing volatile organic compounds or VOCs (I'll discuss this in detail in Chapter 2). We also found that these plants, when grown under the right circumstances, could give us an abundant supply of fresh air. This solution has been validated by Bill Wolverton, a NASA scientist best known for his research on how houseplants can reduce indoor air pollution.

We were very excited by these findings. We knew we were on the cusp of something with tremendous potential. If we cracked it, it could both change and save lives.

Today, PBC is the healthiest workspace in the National Capital Region (NCR). This has been certified by the CPCB. With its 7000-plus plants placed throughout the six-storeyed building, PBC is what I like to call a living laboratory. Every day a team monitors the air quality inside

Introduction

the premises and another keeps it fresh and clean at all times. This is done by various means such as the use of heat exchangers, electrostatic precipitators, activated carbon filters, catalysts to remove sulphur oxide (SO_x) and nitrogen oxide (NO_x), energy wheel, Hepa filters, titanium dioxide and UVC box, air washers, ultraviolet (UV) lights and a high efficiency cooling tower. Even on the days when Delhi chokes because of air pollution, the people and organizations that rent space at PBC are guaranteed fresh air for every minute they spend inside.

Close to 500 people set foot in this building every day. If you ever visit us, you'll be amazed by the crisp, mountain-like air we breathe. And you'll be even more surprised to find that we enjoy this wonderfully clean air bang in the middle of one of New Delhi's busiest and most polluted office districts – Nehru Place, which is visited by over 1,30,000 people daily!

Our clients have included 330 plus-multinational corporates including Microsoft, HP, Intel and Mannesmann Demag, 3M, GM,

How to Grow Fresh Air

Hallmark, Lasalle, Mobil, Motorola, Sony Pictures, Shell and Wrigley, and others from Australia, Bermuda, Canada, China, Finland, France, Greece, Germany, Holland, Hungary, Hong Kong, Ireland, Israel, Italy, Japan, Korea, South Korea, Singapore, Spain, Sri Lanka, South Korea, Switzerland, Taiwan, the UK, the UAE and India. They have all used our office facilities and services.

Our air pollution solutions are also being taken forward by Breathe Easy, a company founded by my son-in-law, Barun Aggarwal. Breathe Easy was born in 2013, much the same way PBC came into being. Like me, air pollution had become all too grave a threat for Barun to ignore.

In 2010, Barun returned to Delhi from the US with his wife and two children. On some afternoons, when he would take his children to Lodhi Gardens, he noticed that they would start wheezing after a few minutes and would be unable to run around and play. His wife, my daughter Salonika, too started having trouble

Introduction

breathing. The clean air in the US had left them completely unprepared for Delhi's poisonous air.

During a one-year sabbatical in 2012, sitting up in the mountains of Yamnotri breathing perfect air, Barun decided to do something about this problem, and soon Breathe Easy was born. The company provides clean air solutions to individuals and organizations, by testing the air quality and offering tailor-made solutions for clean air while continuously monitoring the air quality to make sure it always remains clean and fresh. This is done by using different kinds and combinations of air filtration technologies. Some of the places Breathe Easy has helped include Select Citywalk mall, the German School, the American Embassy School, the Embassy of France, FabIndia Corporate Office, Hero offices in Delhi and over 10,000 homes.

Barun and my journey has been long and interesting, often punctuated with questions and dead ends. But then, as Yoda says in *Star Wars*, 'In a dark place we find ourselves . . . and a little more knowledge might light our way'

we too found some of the answers we had been doggedly pursuing.

An old problem aggravated

For Delhiites, air pollution has become a household term only recently, after it started making headlines. But Delhi has always had a history of bad air. The pre-CNG days in the capital were marked by smog. Our eyes would itch and well up every time we stepped out into the streets. It was only in 2001, following the PIL where the Supreme Court ruled that Delhi's public transport system needed to switch to CNG, that Delhi started breathing easier. But the good days didn't last too long. This is because vehicular pollution isn't the only reason the capital's air is so bad. There are several other reasons that contribute to this, such as a historical problem that resurfaces every year.

Every autumn when the rice harvest comes to an end, farmers in Delhi's neighbouring states – Haryana, Uttar Pradesh and Punjab – burn

Introduction

paddy husk in their fields. This is a necessary ritual to cleanse the field before they sow wheat for the next crop cycle. However, crop burning leads to severe air pollution in Delhi, as toxins in the air from these neighbouring states mix with the pollution caused by vehicular and industrial pollution, leading to a deadly concoction that Delhiites are forced to breathe every year.

Despite a ban on crop burning under the National Green Tribunal Act of 2010, it continues to be an annual affair in North India because state governments are yet to come to an agreement about what regulations need to be in place to stop the burning of paddy husk. They also need to arrive at a cost-effective solution to clean the residual crops from the fields in these three states.

Just as autumn slips into winter, Diwali celebrations begin in India, especially in the northern states, adding to the already polluted air with crackers being burst in almost every neighbourhood. In 2016, on Diwali night, a reading of 3240 micrograms per cubic metre

How to Grow Fresh Air

was recorded. The annual average permissible exposure as per the World Health Organization (WHO) is 10 micrograms per cubic metre. A Supreme Court ban on the sale and use of crackers during Diwali in 2017 led to a huge outcry about religious sentiments being hurt, but ensured people breathed a little easier. However, the ban has done little to stop crackers being burst throughout the wedding season, which kicks off in late autumn and carries on through the winter months. Also, people on the roads start bonfires made of plastic, paper, rubber and leaves to keep themselves warm in the brutal cold. These makeshift fires aggravate the already polluted air.

In the winter months, the problem gets compounded. Hot and cold air currents power the weather systems on earth. A phenomenon called temperature inversion occurs in the winters when a layer of cold air is trapped closer to the earth's surface with a front of warm air. This trapped cold air is polluted and is not allowed to escape the lower levels of the

Introduction

earth's atmosphere. This has a direct result on air pollution, because the dust and the toxins in the air, which in summer would rise with the air and then cool down and descend as colder, cleaner air, struggle to do so in winter. As a result, all the pollution particles remain trapped closer to the ground where we live and breathe. When this polluted air is unable to rise upwards, or vertically, it starts moving horizontally, filling our living spaces, making the air heavier and difficult for us to breathe. Cities are the first to be hit because restricted spaces make it even more difficult for the air to travel than open fields. And so we end up with a thick blanket of hazardous smog.

India is one of the most polluted countries in the world

The problem isn't just limited to Delhi.

In May 2018, WHO released its global air pollution database which had a shocking statistic. According to this report, **India is home**

to fourteen of fifteen cities in the world with the worst air.¹ The cities in order of most polluted are Kanpur, Faridabad, Varanasi, Gaya, Patna, Delhi, Lucknow, Agra, Muzaffarpur, Srinagar, Gurugram, Jaipur, Patiala and Jodhpur. Indian cities, irrespective of size, are choking under air pollution.

One of the main reasons for this is urban migration. With more and more people from villages, towns and smaller cities choosing to move to bigger metropolises, the need for housing and transportation has gone up, which has added to the problem.

Emission from cars is one of the largest contributors to bad air quality. In India, vehicles are not regularly checked for their Pollution Under Control (PUC) certificates, which is a mandatory licence to certify that emissions from a vehicle meet the pollution standards. This certificate needs to be renewed every three months, but very few people do so.

Most diesel vehicles add another big chunk of their share to air pollution. They are the

Introduction

biggest contributors of nitrogen oxide and PM 2.5 because they do not have diesel particulate filters (DPF) fitted on to their tailpipes. India is currently on Bharat Stage III and Stage IV fuel which has very high sulphur content (500 ppm and 150 ppm respectively). Thanks to a Supreme Court order, we have skipped Bharat Stage V fuel and will move directly to Bharat Stage VI fuel, which has the least sulphur content (10 ppm) that can be filtered with DPFs. Earlier versions of fuel could be filtered with a DPF as the filter would get choked due to the high levels of sulphur. Delhi is currently the only city to get Bharat Stage VI fuel, but the rest of the country is expected to get this by 2020 if our refineries upgrade on time, which will cost approximately ₹80,000 crore. Some of the largest refineries of the world are based in India and we export the best fuel (Euro VI), but the citizens of India are left gasping for breath due to poor fuel supplied by our own refineries.

You will find the term PM 2.5 throughout the book. PM or particulate matter is tiny pieces

How to Grow Fresh Air

of very fine solids and liquids that mix in the air which we inhale. These are extremely harmful for our health. And when these solid particulates absorb the harmful gases in the air, their toxicity increases manyfold. The smaller the particulate matter, the more dangerous it is because it then goes deeper into our lungs and even into our bloodstream.

PM 2.5 are fine particles that are about 2.5 micrometres in diameter or smaller. Typically, PM 2.5 particles are classified as particles that range from 0.3 micrometres in diameter to 2.5 micrometres. Let me paint you the picture: about 25,000 microns make an inch. A human hair is about 70 micrometres in diameter. Tiny though they are, they can be deadly. Inhaling these pollutants constantly can lead to cardiac arrests and strokes. In an extensive study conducted by Rice University, USA and the Houston Fire Department, EMS, USA, it was found that only a slight increase in the levels of PM 2.5 – as little as a 6 microgram per cubic metre increase

Introduction

over a two-day period – raises the risk of out of hospital cardiac arrests (OHCA) by nearly 5 per cent. OHCA are cardiac arrests experienced at home or in public places.

Unfortunately, citizens remain largely unaware of the effects of air pollution. Every year the same story repeats itself and the pattern has now become so predictable that I don't think anyone really cares about it. Air pollution makes a great news story, and that's about it. But if you do care about your health and life, then this book is for you.

Why fresh air is vital

Once upon a time, owning a fancy car or a house at a coveted address was a luxury. Today, this also includes fresh air. Those who can afford it uproot their lives and move to cleaner, greener cities. But how many of us can do that? It is unfortunate but the truth is that the common man usually ends up at the doctor's clinic to seek

How to Grow Fresh Air

help for the many preventable diseases caused by air pollution.

The tragedy is that we haven't realized the importance of fresh air in our lives and the impact it has on our health. Fresh air not only saves us from respiratory and cardiac diseases, it is also proven that it improves our cognitive powers.

Yes, fresh air helps us think better and become smarter. Most importantly, it helps us raise healthy children who are the future of this world.

The simple things in life that we take for granted, like a good night's sleep in a well-ventilated room, can make a huge difference to our daily lives. Yet, at the same time, a walk on a winter morning can do us more harm than good. It's time we paused and assessed the lives we lead. Small lifestyle changes like carpooling or doing away with the plastic shopping bags we use for our groceries or even the long meetings we put ourselves through at work can make a difference. We are now living in a world where every little action will affect and shape our

Introduction

future. It is for us to decide the kind of future we want for ourselves and our children.

The most important point I'm trying to make with this book is that **everyone can enjoy the benefits of fresh air**. Our homes and other indoor spaces where we spend most of our lives are also very toxic. But this is one problem we can fix. Because, unlike outside air, our homes are under our control. So, this is the space we should focus all our attention on and ensure the air is clean.

In this book, I will share with you practical suggestions, recommendations and solutions on how best we can have clean air indoors. Implementing some of these measures and suggestions can change your life dramatically. It may mean changing the way you live or rearranging your homes. Or simple actions like keeping your bedrooms clean and carpet-free can reduce the toxicity levels in your home. Some of it may seem impractical to you at first, but it is just a matter of getting used to the changes. The benefits of these suggestions far

How to Grow Fresh Air

outweigh the temporary discomfort you may face. What are a few minor sacrifices if you can protect your family from many preventable illnesses?

It's not always easy to embrace change, but it's not all that difficult either! It's just a matter of perspective. And it's the least you can do for yourself and your family.

Today, at PBC, we have excellent air quality inside the building. On the day after Diwali last year, our building's PM 2.5 level was below 15 micrograms per cubic metre whereas Delhi's air was over 400 micrograms per cubic metre.

That's something, isn't it?

I believe this is an important book, one that can greatly change and improve your living conditions. I have been implementing these solutions in my daily life for the past twenty years, and I can vouch for the fact that it saved my life. I hope you will benefit from these suggestions just as I have.

It is important to help ourselves and do the best we can to save ourselves from poor

Introduction

air quality so that we can improve our health, productivity and our cognitive ability. Given that our air quality is worsening each year, those who can do something for themselves, should do so now and set an example for others.

As Gandhiji once said, 'Be the change you want to see in the world.'