

**2017 Asian Science Writing Prize  
Science Centre Singapore Youth Writing Prize  
First Prize**

Grains of Hope  
*by Tan Yong Yi*

With empty bellies and sticks in hand, thousands of farmers took to the streets of Mindanao, Philippines, to demand for rice to feed their impoverished families from the government. Yet, instead of seeing officials driving vans carrying sacks of the life-saving grain, what they saw were vehicles of policemen armed to the teeth with guns and anti-riot equipment. The farmers were then duly fed by the police forces, not rice, but something equally small and rotund.

Bullet rounds.

After protests had turned violent, the men in blue opened fire, killing one and wounding a dozen in April just last year. The gruesome skirmish was a result of El Nino, a weather phenomenon that plagued the Filipino farmers with drought, causing them to lose over \$150 million in rice and corn. Many farmers over the world face similar problems in agriculture due to unforeseen climate conditions wrought by global warming, ranging from intense droughts to extended monsoon seasons. The supply of rice is especially threatened, given that many farmers who work in the paddy fields struggle to make ends meet. Furthermore, the rice plant itself is susceptible to minute changes in heat and a wide variety of pests that have flourished from an increasingly warm and humid climate.

It's no secret that Asians love their rice, with more than 90% of the humble grain being produced and eaten in Asia. In fact, in South East Asia alone, close to 100 million tons of rice was consumed in 2011, which equates to roughly more than 3 heaped bowls of rice each day per person! Thus, rice is one of the main drivers of society in Asia, with governments even rising and falling due to the supply of this beloved staple in many Asian countries. Yet, farmers in the paddy fields, such as those in Mindanao, are feeling the heat, literally, as both demand for rice and global temperatures rise steadily each year. The result is a growing concern that in the near future, Asia would be unable to curb the insatiable appetite for rice with shrinking supplies. However, researchers

in Singapore have innovated a new breed of rice that might just put these fears to rest.

This wonder grain was developed at Temasek Life Science Laboratory (TLL) in Singapore by Dr Yin Zhong Chao with a multi-national team of scientists, and is aptly named “Temasek Rice”. This new breed of rice is known to be able to stand up against extreme weather conditions such as droughts and floods, and “hibernates” for 2 weeks when submerged in water. The rice plant itself is a dwarf amongst its brethren, which is an advantage since the shorter stalk prevents it from bending too much when strong winds blow. It can also fend off bacterial and fungal diseases as well as produce higher yields. In fact, Temasek rice produces up to 6 tonnes of rice grains per hectare of paddy field, which is nearly four times the yield normal breeds of rice give. This makes Temasek rice a sturdy powerhouse that can withstand extreme fluctuations of the weather caused by global warming, as well as allowing farmers in Southeast Asia to grow rice more sustainably.

Not only does Temasek rice stack up well practically, it also passes the taste test with flying colours. Dr Yin has described the grain being more aromatic, softer and tastier than most other brown rice varieties, in addition to being nutritious since it possesses a high amount of dietary fibre. After eight years of research and field trials, the rice has landed on shelves in Singapore and is sold at around 7 SGD per 1 kilogram pack.

So, was it just a matter of green thumbs that Dr Yin and his team managed to produce such a hardy grain?

Partly, as the research process had involved the traditional technique of cross-pollination, a tedious method many horticulturists swear by, where pollen from a donor plant is transferred to a recipient plant in an attempt to produce offspring that possess traits from both plants. Yet, if the team had only utilised this method, Temasek rice surely would not be on our bowls after just eight years of research, since long periods of time are spent cultivating the various breeds of rice in the laboratory.

That is when marker-assisted breeding (MAB) comes into play.

Essentially, this technique stems from genomics, and is an indirect selection process in cultivar development. The organism’s DNA is first isolated and analysed using techniques such as gel electrophoresis or Southern blotting, and its traits of interest is selectively bred based on

markers on the organism's DNA found from the analysis that is linked to the trait itself. These markers are variations in the DNA that include changes in the base pairs or patterns of repeated base pair sequences. The technique relies on the assumption that such markers are tightly linked to the trait of interest, and that these traits are easily inherited by the offspring. In comparison, the traditional method of phenotypic selection involves selecting the plants for breeding by directly observing or testing for the traits they express.

The advantages of MAB is numerous in comparison to phenotypic selection, as they provide a rapid method for cultivar development, taking at most 5 years to develop a new cultivar as opposed to 15 years taken by conventional breeding methods. This is because traits that are expressed late in life, such as the nutritional value of fruits produced, can be detected as early as during the plant's seedling stage through DNA testing. Furthermore, traits that are difficult or expensive to analyse such as the plant's resistance against bacterial and fungal infections can also be screened through MAB. In addition, MAB has high accuracy, since the markers which are tightly linked to their respective traits would not be affected by the environment. Best of all, MAB executes gene pyramiding with ease and efficiency, which is a method that allows multiple traits to be accumulated within the same cultivar. Temasek rice is a prominent example of gene pyramiding, as it is not only resistant to environmental stress and disease, it is nutritious and even palatable as well.

Dr Yin and his team have tinkered with the natural defences of plants on a molecular level for many years, especially with regards to crop productivity. His objective in this was to create a positive impact in the agricultural community, being frightfully aware of the problem of food security that looms like a distant thundercloud after witnessing a food supply crisis grip Singapore in 2008. Hence, Dr Yin combined his experience in the field and the wonders of MAB to generate an expansive library of new and improved rice plant varieties enhanced with a plethora of eye-catching traits. In fact, the Temasek rice was a "golden-ratio" result of breeding the familiar jasmine rice plant, whose grains many of us wolf down during dinnertime, and five other rice plant varieties. Dr Yin has since used his results to further benefit the agricultural community in the region, by introducing Temasek rice as a driver for sustainable farming in Southeast Asia.

The professor initially collaborated with local researchers in Aceh, Indonesia to improve rice varieties in the region for farmers to plant after their livelihoods were destroyed by a tsunami. Since then, Dr Yin has expanded this project to small-scale planting of Temasek rice by local farmers in Tasikmalaya, Indonesia.

Addressing the need for sustainable farming practices and giving farmers a secure livelihood, Dr Yin had said, "Farmers work very hard and their income is very low, so we want to create good rice that allows for stable production, and produces grains of good quality so that they can be sold for high prices."

It is no small feat for a country without any paddy fields or rice farmers to go against the grain and create a sizeable impact on regional rice-growing efforts. Yet, Dr Yin did just that, allowing Singapore to for a boldly into agriculture. In fact, Dr Yin's grains had the honour of being inducted into the Svalbard Global Seed Vault, otherwise dubbed the "doomsday vault", which contains seeds of over 4,000 plant varieties in case food supplies need to be regenerated after global catastrophe.

With Temasek rice slowly filling up paddy fields in the future, it is a relief for the farmers of Mindanao to know that there is still a grain of hope in bringing a bowl of rice to the table.

**2017 Asian Science Writing Prize  
Science Centre Singapore Youth Writing Prize  
Third Prize**

OCD: The Killing Joke.  
*by Lim Ting Wei*

Beads of perspiration rolled down his forehead. His hands are clammy as he grasps the door handle of his car for the 47<sup>th</sup> time. It doesn't budge, assuring him that the door is firmly locked. Yet the man found it impossible to walk away because as soon as he lets go of the handle, a kernel of doubt starts to loom large within his mind, eventually growing into something monstrous. A distressing thought hijacks his brain, 'What if the door was not properly locked, my child would die as a result.' He knows that is not true — his children were safe away in school, an unlocked handle would never imperil them. Nevertheless, the idea became firmly embedded within his mind, sticking like a freshly chewed gum. Consumed with fear and anxiety, he returned to check the door handles again. However, it only provided temporary relief as the doubt would quickly return and so the compulsive need to check his door handle would have to be done again, and again, and again. He was already 3 hours late for his job his boss would fire him if he were late again but the only way to relieve himself from the anxiety was this ridiculous, irrational ritual of checking his door handle over and over again.

Forget those caricatures of Obsessive Compulsive Disorder (OCD) in films and novels. Forget those glamorized representations of OCD in popular media. This is the grim reality of OCD, an anxiety disorder characterized by persistent anxiety and ritualistic irrational actions to combat the resulting anxiety. This crippling disease results in at least a daily impairment of one hour.

On the surface, OCD may resemble addiction, except, a gambling addict is driven to gamble repeatedly because of the pleasure he derives from the action, but patients suffering from OCD do not find their compulsive ritual pleasurable. Instead they experience intrusive, distressing thoughts that result in persistent anxieties. They are then compelled to engage in repetitive behavior in order to relieve the resulting anxiety. But the anxiety does not go away and sufferers end up trapped in an unending loop of misery which sucks away much of their time and energy. Some times, it can be severe enough to require medical intervention. A Brazilian man named Marcus who was suffering from OCD had obsessive thoughts about the shape of his eye sockets, so much so that he was compelled to feel them constantly with his own fingers. The constant touching eventually made him blind.

The World Health Organization recognized OCD as one of the top ten most disabling disorders in terms of its effect on quality of life. Many of us may be unaware but the problem is much closer to home than expected. In 2011, the Singapore Mental Health Study found that Singapore was the OCD capital of the world, with OCD rates three times as high as that of Europe. Latest figures from the Institute of Mental Health (IMH) showed that 1 in 33 Singaporeans suffer from this anxiety disorder, yet only 1 in 10 patients seek any form of treatment. Even when they do, effective therapy is often stymied by a misdiagnosis of depression or anxiety. Dozens different drugs have been tried and tested for OCD – LSD, lithium, Fluoxetine, sertraline hydrochloride, amphetamines, nicotine patches and even horse tranquilizer ketamine. Treatment is like more playing Russian roulette, because some treatment might work like a miracle drug for some but aggravates the situation for others. There is no univocal opinion concerning treatment of OCD because its neurobiological basis is still poorly understood.

For many years, people have sought to unravel the etiology of this illness. In the past, many wrongly ascribed it to possession by an evil spirit. With the progression in the field of psychiatry, the explanation for OCD shifted from a religious view to a medical one. At first, doctors attributed it to manifestation of melancholy, then as a psychological problem in the 20<sup>th</sup> century, implying that it was caused by life events, such as a traumatic childhood. By the

21<sup>st</sup> century, emerging evidence showed that OCD is caused by an interplay between physical and chemical abnormalities in the brain itself. Today, we understand it as a medical condition rather than a psychological one.

It is once said that all behavioral disorders constitute the misfiring of an otherwise adaptive pursuit. Evolutionary biologists believe that OCD is a side effect of our evolved capacity to anticipate future threats. It is theorized that the brain generates risk scenarios randomly to allow individuals to develop harm avoidance behaviors without actually being exposed to these dangers in real life. While this neurological system conferred a clear advantage on those who possessed this trait over others, it also renders us vulnerable to developing OCD should this brain circuit goes awry. For example, it is perfectly normal for person to wash their hands after touching something dirty because there is a risk of bacterial infection. A healthy person would stop washing their hands upon recognizing that it is clean and is able to move on. This control is deficient in OCD patients. Instead of moving on, the act of washing their hands mutate into an obsession as their consciousness clings resolutely onto these scenarios and refuses to adapt according to external changes.

Despite its severity and prevalence, there is still a paucity of data concerning their pathogenesis and treatment.

What we do know is that OCD involves dysfunction in the frontostriothalamic brain circuit, a network that allows us to change our behavior according to environmental demands. This neuronal circuit starts in the orbitofrontal lobe, moves to the cingulate gyrus then into the caudate nucleus and the thalamus before going back to the orbitofrontal lobe. The question we want to answer is: Where, in this circuit, has something gone wrong?

In 2004, neuroscientist David Mataix-Cols and colleagues reported that patients with different OCD symptoms exhibit abnormalities in relatively distinct components of the frontostriothalamic circuits. Unlike previous neuroimaging studies of OCD that have grouped together patients with mixed symptoms, they separate them according to the different symptoms they exhibited, namely washing-related, checking-related and hoarding-related. The researcher then exposed these patients to pictures of dirty bathrooms, open car doors and old newspapers respectively.

Patients that exhibit excessive washing behaviors demonstrated greater activation than healthy controls in bilateral ventromedial prefrontal regions and caudate nucleus, suggesting that washing-related anxiety is associated with regions involved in the processing of emotions, specifically disgust.

As for checking-related anxiety, patients showed greater activation in the thalamus, Globus pallidus and the cortical motor strip. In contrast to washing-related anxiety, there is more association with dysfunction in a circuit that is essential for paying attention and reflective bodily movement as well as the inhibition of unwanted impulses rather than emotion processing.

The results were more confusing for hoarders, as researchers observed hyper metabolism in a variety of frontal regions. This suggests that it may be a different disease entirely and was hinted by the fact that these patients often respond poorly to common OCD treatments.

David's study suggests that conceptualizing Obsessive-Compulsive Disorder as a spectrum of syndromes rather than a single entity may help doctors make better treatment decisions.

Even more recently, researchers from Central South University of Changsha in China reported widespread small-scale defects in the brain's white matter in patients with OCD. These white matter tracts act like 'bridges' that allow information to be exchanged between

different parts of the brain. These findings suggest that OCD may involve abnormalities affecting a broader network of regions than commonly believed.

All these findings point towards the fact that OCD is much more complicated than originally thought and there is so much more left to be discovered. Further research will continue to shed light on this devastating illness. For now, we will need to confront the stigmatization and trivialization of mental illness in Asian culture. While many countries in Asia are beginning to take progressive strides to address mental health issues, much of their mental health programs revolved around more 'threatening' mental illnesses such as Schizophrenia, ignoring common but disabling mental illnesses such as OCD. Also, psychopathology of OCD were relatively fewer in Eastern Asia than that in western countries, with studies predominantly done only in Japan or Singapore.

Once relatively obscure, Obsessive Compulsive Disorder has been catapulted into the limelight with the rise of comedy films like the *Monks*, popular threads like #ObsessiveChristmasDisorder and coffee mugs with one liners that read 'Obsessive Coffee Disorder'. Despite the way that it was popularized, we ought to recognize that it is much more complex than a clean bathroom, color organized markers or a clever one liner on your coffee mug.