# Regenerate Australia

Why regenerating the health and resilience of our soils and bio-systems is now critical to secure our safe climate, water, food needs, viable regions and future.

A sequence of briefs on how lead farmers are regenerating the resilience of 300 million hectares of Australia's inland and northern rangelands in the front line and at risk of, climate extremes, increased wildfires and desertification.

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August 2013

**Regenerate Australia** Healthy Soils Australia

**Why regenerating the health and resilience of our soils and bio-systems is now critical to secure our safe climate, water and food needs, viable regions and future.**

**Executive summary**

Australia, as all nations needs to respond to pending extremes from intensifying; climate changes, resource limits, population demands and diminishing resources, in a world with financial, economic and regional uncertainty. In doing this it needs to:

1. Recognize that Australia, the driest inhabited continent, is already in the front line of climatic extremes that threaten the stability of natural and regional communities.
2. Recognize that the future of Australia's community and economy depends primarily on the health and resilience of its natural eco-systems in facing these extremes.
3. Regenerate the natural health and resilience of its bio-systems and their capacity to supply our essential; water, food, bio-material and ecological services needs.

Business as usual, and the land management systems that helped create these pressures can not deliver these essential outcomes. We and they need to change, urgently.

Fortunately Australia still has the natural and economic means to make these changes. To do so we must urgently regenerate the health and resilience of our soils and landscapes so as to restore their natural capacity to buffer extremes and sustain these bio-systems.

The following Regenerate Australia vision outlines how we can do this; so as to secure:

**1.** Resilient bio-systems able to buffer and cool climate extremes.
**2.** The sustained draw down of carbon from the air back into our soils to help in this.
**3.** The natural ability of Australia's soils to infiltrate, retain and sustain water supplies.
**4.** The sustainable production of high quality food to help feed up to 1 billion people.
**5.** The transition of Australia's regions and economy to a viable low carbon future.

These briefs detail why we must, what is required and a sequence of strategies to do this.

The briefs specifically focuses on how we can regenerate the resilience of 300 million hectares of rangelands in Australia's inland and northern dryer regions that are in the front line and at risk of climate extremes, increased wildfires and desertification. On why these changes, all of which are fully substantiated scientifically, economically and commercially, need to be made at practical grass roots levels, this decade before locked in dangerous climate, resource and social stresses impede our options to do so.

While regeneration strategies need to be tailored for each situation, these briefs may be relevant globally in sustaining the 5 billion hectares of remaining similar rangelands and in regenerating some of our 5 billion hectares of man made desert and wasteland.

## 1.Why we must regenerate Australia and similar rangelands, globally.

As evidenced by Bureau of Meteorology and CSIRO, Australia has been aridifying for over 100 years with systemic declines in rainfalls, along the east coast, in inland Australia and via the systemic decline in SW Western Australia from the 1970s. Conversely monsoonal rains have increased in NW Australia. Projections indicate that southern Australia may receive up to 30 % less rain within decades from a far more variable unreliable and extreme climate.

These rainfall extremes will greatly increase the incidence of storms, floods, droughts and wildfires and their dangerous, destructive impacts. These aridification and wildfire impacts will in turn threaten many natural bio-systems, agricultural sectors and the communities and economies that depend on them for their wellbeing, and significantly;

- Degrade natural water, soil and bio-system values and their ability to supply our needs,
- Threaten the stability of many societies as essential water and food supplies deteriorate,
- Intensify financial and debt crises and risks to asset and natural capital values,
- Risk major health crises as populations age and concentrate without the needed support,
- De-stabilize sectors, regions and nations with strategic consequences for Australia.

These crises cant be avoided by business as usual; nor the current policies that contributed to them. Just reducing future carbon emissions can and will not prevent these dangerous climate extremes. Instead we must avoid these risks and impacts and reinforce the resilience of bio-systems to do this.

Indeed, they can only be avoided by urgent global grass roots action, to regenerate the health and resilience of the bio-systems that all economies and societies depend on to secure their safe future. Leadership, vision, certainty, trust and a blueprint for the a national transition is needed urgently. While Governments must lead and catalyse these urgent changes, only local action by self interested empowered communities can now effect the needed changes at the scale and speed required to;

1. **Reinforce the natural resilience** of our bio-systems so they can sustain essential outputs.
2. **Cool regional climates**, hydrologically, to help offset induction of the dangerous extremes.
3. **Draw down carbon** from the air back into stable soil and biomass sinks to help them do this.

For Australia to do this it must take urgent, direct action to;

1. Limit the intensity and impact from extremes such as wildfires on key at risk bio-systems.
2. Buffer front line bio-systems being impacted by these extremes to prevent their collapse.
3. Restore the resilience of key natural and social systems to help them survive such extremes.
4. Secure and sustain the essential; water, food and habitat needs for future populations.
5. Facilitate the transition of key regions to an equitable and sustainable low carbon future.

The following explores practical options for how we can do this, particularly over the 300 million hectares of inland and northern rangelands at highest risk of degradation and collapse due to the continued aridification of our climate and the more intense wildfires that are resulting from this.

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## 2. Australia's climate reality, the key pending risks and action priorities to address them.

Bio-systems, not unlike chains, break and collapse at their most vulnerable 'brittle' dependent link. In most cases this depends on whether they can access adequate essential water for their survival.

This is particularly acute in Australia, where semi arid rangelands have survived, by adapting to our unreliable low rainfalls and often highly leached degraded soils. With climate changes many face increasing aridification and more intense wildfires, that threaten their collapse and desertification.

Priority must thus be given to protect these at risk rangelands and regenerate them so as to;

1. Maximize their Infiltration, conservation and effectively use of every drop of their more variable rainfall so as to maintain plant and soil moisture levels to limit such wildfires,
2. Restore their former soil carbon 'sponges' and 'in soil reservoirs' so as to retain every drop and extend their longevity of green growth and ability to bio-sequester soil carbon.
3. Limit their current high evaporation and desiccation by aiding their natural regeneration of shelterwoods to hydrologically cool climates and aid their carbon and nutrient dynamics.

Just as these hydrological features enabled Australia's semi arid rangelands to evolve, extend and survive over 95% of Australia's dry interior, their restoration is now critical if we are to prevent the collapse of these bio-systems in the increasing extremes and degradation with climate changes.

Fortunately, we can still do this, commercially at local, national and global levels and at minimal net cost to the public, provided we urgently regenerate these natural hydrological processes.

Specifically to regenerate the former soil carbon sponges that sustained these processes by;

1. Limiting the current oxidation and loss of carbon from these soils through wildfires. To do this we must restore the natural grazing ecologies that bio-converted fire fuels into bio-fertilizers and soil carbon.
2. Enhancing rainfall infiltration and the water holding capacities of soils via this increase in their soil carbon content. In turn this will increase their ability to sustain green growth, reinforce hydrological cooling effects and thereby significantly reduce the risk and intensity of wildfires.

Collectively the above can help regenerate and increase the bio-productivity and carbon draw down potential of Australia's extensive rangelands, despite pending climate extremes.

These highly evolved hydrological adaptations enabled Australia's natural landscape to buffer and be resilient in the face of often acute climate extremes. We need to urgently restore these processes to regenerate Australian bio-systems and the viability of their communities at risk from such extremes.

To do that we need to catalyse the widespread adoption of effective wildfire mitigation and soil regeneration practices over large parts of Australia's 600 mha of rangelands at risk of such extremes. Given its scale and urgency we can only do this by restoring the natural biological fuel reduction and soil carbon regeneration processes via our current land managers and wise grazing ecologies.

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## 3. Limiting wildfire impacts via the biological reduction of fuel and wildfire risks.

As climate extremes, aridification, heat waves and lightening storms intensify, extensive bio-systems will be at increased risk from more intense wildfires and the collapse of dependent communities. Currently 30 mha and up to 120 mha of Australia's 770 ma are currently burnt annually by wildfires. Globally, wildfires burn 350-450 million hectares each year. A further 1-2 bha is burnt annually via hunting, agricultural and fuel reduction burns. These fires emit far more carbon than our industry. Even though ignored in accounts, such fires, their emissions and risk of impacts must be addressed.

While most Australian vegetation is adapted to, and may partly recover from fires, many forests, tundras and rainforests, are at risk of permanent collapse from fire; with these risks posing one of the greatest threats to bio-systems and dependent communities from locked in climate extremes.

Conversely, fire is also a natural ecological tool and risk that humanity can manage to its advantage. Indeed fire has been fundamental in the evolution of life on land over the past 420 m years by oxidising plant material back into heat, water and C02 as an opposite and balance to photosynthesis. In this balance every molecule of carbon that has ever been fixed by photosynthesis has either been;

- Oxidised by fires, micro-organisms or biota back into CO2 and in so doing mineralized soil structures and bio-systems back to their original physical and chemical constituents; or;
- Bio-sequestered microbially into stable soil carbon and in so doing create the soil structures and their water retention that underpins the resilience and productivity of bio-systems.

It is the balance between these two processes that governs if bio-systems build natural capital, resilience and productivity or degrade as their soils are oxidized to re-form inert mineral detritus. It is the balance between these processes that governed the evolution of the Australian landscape.

Due to Australia's dry variable climate and leached soils with low nutrients, plants often produce large quantities of sclerophyllous litter which may be slow to bio-degrade accumulating to induce hot fires. These can oxidize soils, forming exposed, acid, leached soils with very low carbon levels and the progressive degradation and desertification of bio-systems. By contrast in grassland and rainforest soils where nitrogen fixing and bio-degradation organisms can establish, litters can be more rapidly bio-digested microbially into stable soil carbon, reducing fuel levels, fire risks and aiding the rapid re-cycling of limited nutrients to enhance productivities. These high carbon soils enhance the retention of water, plant growth and thus more carbon fixation.

Humans have directly and massively influenced these fuel and fire processes via their grazing and land management resulting in major consequences to soils, hydrology, bio-systems and the climate. These processes have governed the residual vegetation of most regions including Australia where;

1. Up to 10,000 years ago large numbers of herbivores, including browsing megafauna, bio-converted vast quantities of sclerophyllous plant material into dung and soil carbon enabling them to infiltrate and retain rain and sustain the longevity of green growth over large areas of inland Australia. These moister conditions and enhanced nitrogen supplies sustained higher litter bio-degradation rates, reduced fuel levels and thus the incidence and intensity

of wildfires as evidenced by charcoal and soil data. The resultant green savanna woodlands extended over much of inland Australia, as did a stronger Australian monsoon.

2. With the extinction of Australia's megafauna, browsing and bio-fertilizer inputs declined resulting in a marked increase in fuel levels, fire intensities and impacts. The Aborigines had to rapidly develop fuel reduction practices to lower wildfire risks threatening their survival. Their extensive regular cool wet season burns reduced surface fuels but did not oxidize the deeper soil carbon that accumulated often to levels as high as 10% in many grasslands. The large numbers of grazing marsupials and leguminous 'fire weeds' fostered by these burns sustained nitrogen inputs adequate to enable the fungal bio-conversion of litters into soil carbon, but not enough to accelerate the microbial oxidation of litter and soil carbon.
3. With European occupation and restriction of Aboriginal fuel reduction, fire risks, intensities and impacts increased markedly. This has now further intensified with the aridification of southern and eastern Australia due to climate changes and desiccation with clearing. Fuel levels and fire risks have also been intensified by exotic fuels such as Gamba grass and woody weeds proliferation. that increase fuel levels and continuities.

As we have created these increased fire risks we need to take responsibility for and manage them. However, the increased aridification, higher fuel loads, resource restraints and shorter safe periods make this almost impossible in most regions , via just hazard reduction control burns. We need to find safer, more effective ways to reduce these fuel levels, fire risks and impacts. This includes restoring the herbivore ecologies that helped naturally control fuel levels and fire risks throughout most of the evolution of the Australian flora and landscape. This is particularly relevant for the 300 mha of inland and northern Australian rangelands that produce up to 3 bt/an of fine fuel and is at greatest risk of collapse due to extreme wildfires with climate change.

While it is not possible to re-introduce Australia's extinct browsing megafauna, safe natural options exist to re-establish fuel and fire reductions via the restoration and controlled management of;

- Australia's billions of small marsupial herbivores that proliferated in our forests and rangelands prior to our introduction of cats and foxes and were highly effective in mixing surface litter with billions of tonnes of topsoil and dung to accelerate its bio-degradation.
- Large herbivores able to help bio-digest the 3 bt of grass fuels and safely bio-convert them into stable soil carbon. Several options exist for doing this including the ecologically grazing of an additional 100m cattle equivalents.

The restoration of such natural, but controlled, herbivore effects would be beneficial ecologically in;

- Bio-digesting much of the dangerous fire fuels that now threaten the viability and collapse of bio-systems and their dependent communities across this region.
- Bio-converting these into vast quantities of carbon to help restore the natural carbon levels of these soils and their 'in soil reservoirs', hydrology, productivity and resilience.
- Returning vast quantities of dung to these soils to aid nutrient cycling, litter bio-degradation and the productivity, carbon fixation and bio-sequestration capacity of these regions.
- Enhancing the re-establishment of natural shelterwoods and bio-diversity in these regions.

More fundamentally, restoring these herbivores may now be our only means to avoid the ongoing aridification and degradation of these bio-systems at most risk from climate extremes and wildfires.

## 4. Regenerating the natural hydrology and resilience of Australia's at risk rangelands.

Due to Australia's aridity and climatic extremes its flora has evolved unique adaptations to water stress and wildfires including via;

1. The formation of deep well structured organic soils that infiltrated and retained rainfalls.
2. Highly efficient root and microbial ecologies that enable plants to access limited water.
3. Highly efficient plant physiologies that limit water use and loss from many arid zone plants.
4. Plant adaptations to help nucleate, harvest and efficiently utilize all rain that may fall.

As a result, and unlike continents with far higher rainfalls, over 90% of Australia's 770 million ha is still vegetated. While often dry, dormant and brown, these adaptations have helped underpin the resilience, productivity and survival of much of Australia's current vegetation.

We have seriously impaired these processes over the past 200 years through our land management inducing the systemic aridification of southern Australia and eastern ranges and its vulnerability to climate extremes and wildfires. These now risk its collapse if not mitigated over extensive areas.

While we can do this in part by restoring ecological grazing to reduce fuel and fire risks we can also help do this by regenerating the natural more mesic, moister soil and within canopy environment.

To do that we need to ensure that landscapes can retain adequate water so they can sustain green plant growth and limit fire risks. Europeans explorers consistently noted how soft and spongy the 'mouldy' surface soils, with often over 10% organic matter contents, were and how they became boggy after rain. We need to restore these former structures, water holding capacities and 'in soil reservoir' status of our soils by similarly restoring their former natural high carbon contents.

Currently some 60% of the Australian landscape may be dry and dormant at any time. However it should be possible to extend the longevity of green growth and thus the resilience of bio-systems to stress by restoring these former soil carbon 'sponges', and their capacity to infiltrate and retain rain.

Australia's bio-systems currently fix 2.3 billion tonnes of carbon/annum even after losses by fire. By bio-sequestering more of this carbon into the soil, we should be able to conserve more rainfall in their restored natural 'in soil reservoirs' and aid the resilience of landscapes to climate extremes. This could potentially extend the longevity of their green growth from 40 to 70% of the time and fix an additional 2 btC/an from Australia's existing natural vegetation.

Extending the longevity and area of green growth should also aid in the natural regeneration of the 'shelterwoods' that are often killed by repeated fires but are critical in limiting surface winds and the desiccation of rangelands. Currently 50 rain drops out of 100 may be lost to runoff or evaporation. Shelterwoods, by limiting this loss can aid the resilience and productivity of such brittle rangelands.

Just as nature did in the evolution of Australia's unique highly resilient and productive bio-systems, we too can now use these same processes to restore the resilience and productivity of our natural and rural bio-systems. To do this we first need to ensure that our current rangelands can survive the aridification, climate extremes and wildfires that are now inevitable and threaten their collapse.

We need to urgently and practically limit the wildfires that risk degrading and desertifying vast areas of inland and northern Australia. We can do this naturally by restoring the former soil carbon sponges that underpinned the structure, water holding capacity and root ecology of these soils and their ability to sustain the longevity of green growth and resilience of these bio-systems.

Restoring Australia's extensive natural 'in soil reservoirs' via such soil and vegetation regeneration should also result in major improvements in the sub-soil recharge of the many springs, creeks and wetlands that were characteristic of Australian former rangelands. In turn these should further enhance plant growth, grazing ecologies, the bio-degradation of fire fuels and soil carbon levels. They should also help ensure adequate sustained water can be sourced from these soils to meet essential stock water and community needs, particularly during the expected increased dry periods due to climate change.

## 5. Providing extra dry season water sources to enable herbivores to control wildfire risks.

Herbivores are often fundamental, in dry open rangelands as 'mobile bio-digestors' to convert plant fuels into animal protein and dung, and prevent the otherwise inevitable degrading wildfires and loss of this carbon via emissions. Indeed this symbiosis between herbivores and grassland that enabled high carbon soils to form and plants to relatively recently extend into brittle environments that had been seasonally too dry or cold, or subject to too intense fires to support perennial plants.

As such the herbivores, or more specifically their gut micro-floras, need to be seen as key agents or tools, not just in limiting fires but in enhancing the soil carbon levels, water retention and nutrient dynamics of these rangelands and thus their progressively increasing productivity and resilience.

However for herbivores to do this they need adequate fresh water, daily. This is acute in seasonally dry climates where the lack of permanent surface water excludes herbivores and can lead to the accumulation of fuels, fire risks and often the degradation of these bio-systems back to deserts.

This seasonal lack of adequate surface water during the last 'dry' ice age may have contributed to the loss of Australia's megafauna and has since restricted grazing over much of inland Australia to highly mobile red kangaroos and insects; and associated increased fire impacts and desertification. .

This lack of seasonal stock water still impedes the optimal ecological management of Australia's rangelands and has led to the recent serious degradation of many of the natural water sources that are critical in preserving the bio-diversity, cultural and resilience values of these bio-systems.

As such, and in the face of aridification and Australia's more variable rainfalls, it is critical that we;

1. Protect and restore these critical natural water sources from stock and feral degradation.
2. Enhance the ecological grazing of these grasslands and fuels via controlled herbivores that don't depend on these natural water sources, particularly during dry seasons.
3. Foster the ecological succession of these at risk rangelands back into the more resilient grassy woodlands and the extensive 'green deserts' that existed naturally; so they can again form the front line in Australia's mitigation and adaption to locked in climate extremes.

To do this we must establish additional controlled stock water points across Australia's rangelands that can be filled from wet season runnoff or recharged from the natural 'in soil reservoirs' that will regenerate naturally in most sites as soils carbon is restored via the controlled ecological grazing.

To limit wildfire risks over Australia's 300 million hectare of at risk rangelands herbivores may need to bio-digest some 3 billion tonnes of pasture annually. This may require the controlled ecological grazing impact of some 100 million cattle equivalents. Given that each cow may require some 50-70 litres of water per day, 2000 billion litres of additional water may be need to be provided annually. As cattle can graze most effectively up to 2 km from water, this water needs to be provided via some 200,000 additional distributed tanks, each of 2-3ML capacity, with these protected tanks being able to be recharged 3-5 times per year from surface, in soil reservoir or deeper groundwater sources.

To maximize their effectiveness, these additional water sources need to be designed so as to;

1. Remove all stock pressures from natural water resources particularly during the dry.
2. Be fenced and controlled so as to aid the management of stock and feral herbivores.
3. Be covered via canopies and/or bio-films to limit often substantial evaporation losses.
4. Facilitate the optimal regeneration and periodic controlled grazing of the rangelands.
5. Supplied via troughs/drippers to limit site impacts and aid the remote control of stock.

Such a distributed network of additional controlled stock water tanks across Australia's rangelands needs to be seen as a critical strategic national asset to enable Australia to sustain these bio-systems as a front line in adapting to pending climate extremes and in meeting critical food and future needs.

Australian farmers and the public have previously subsidised the construction of over 2 million farm dams across southern Australia to help secure national and rural outcomes. The provision of an integrated distributed network of some 200,000 additional controlled stock water sources across Australia's rangelands would use only modest quantities of locally available water equivalent to 20% of the capacity of Lake Argyle but should deliver far higher strategic and ecological outcomes, via:

1. Protecting and restoring our critical natural inland water habitats and bio-diversity.
2. Minimizing the risk of and impact from more severe wildfires due to aridification effects.
3. Enabling the controlled grazing and regeneration of much of inland and northern Australia.
4. Enhancing the bio-sequestration of carbon in these soils and regenerated shelterwoods.
5. Providing a major strategic and economic infrastructure asset for the nation and future.

To ensure they optimally serve; national, on farm regeneration and stock management needs these additional water sources should, and can, be constructed commercially for and by the land managers but with due policy support and incentives and at no net cost to the government or public.

Detailed analyses of the optimal design and management of these water sources, their commercial construction and their economic returns at farm, regional and national strategic levels are available.

While their primary objective is in catalysing this national strategic asset is to help secure the health, resilience and survival of Australia's at risk rangelands in the face of aridification and wildfires due to climate changes, these additional water assets and the ecological regeneration they enable should also deliver major outcomes for these regions in developing; carbon, protein and grain opportunities

However we may be running out of time. We may have less than a decade to limit the degrading impacts of wildfires in oxidising the soil carbon 'sponges' so critical to sustaining water supplies and in preventing the desertification of many of these at risk rangelands.

The construction of these additional dry season stock water storages will be critical to restore the ecological grazing ecologies  needed to reduce fuel levels and these fire risks. At the same time the restoration of these natural grazing ecologies will be critical in regenerating the soil carbon levels, structure, water holding capacities and in soil reservoirs from which the water to sustain these herbivores can be sourced.

## 6. Regenerating soil carbon levels and the retention of rainfalls in our 'in soil reservoirs'.

To ensure that there is adequate water to sustain the herbivores needed to limit fuels and wildfires over the dry season we will need not just extra stock water points; but also the water to refill them. While there is often abundant water in the wet season, the very high evaporation rates of up to 20 mm/day, rapidly limit the availability of natural surface water and thus grazing and wildfire controls.

Isolated large surface water storages such as Lake Argyle have been built but the cost of distributing this water over large distances to supply stock is prohibitive. Similarly while some regions can access groundwater, the areas involved, extraction and distribution costs and water quality can be limiting.

It follows that finding cheaper smarter ways to secure adequate dry season stock water is critical if we are to reverse the degradation of vast areas of rangelands at risk from fire and climate extremes.

Fortunately there are safe natural options to sustain such stock supplies, provided we regenerate the structure of these soils and their capacity to store and supply water from their in soil reservoirs. While often currently degraded, the extensive deep sandy and red and yellow earth soils across much of Australia's rangelands could infiltrate and store meters of extra wet season rain in their restored 'in soil reservoirs' to sustain green growth and stock water, despite climate extremes.

Retaining even 300 mm of additional wet season rain in such restored soil structures, over our 300 mha of rangelands, could potentially store 1 million GL of additional water, equivalent to 100 Lake Argyles. This could secure water when and where it was needed with minimal evaporation and cost.

We can readily secure such additional water across our rangelands by simply restoring the former higher natural carbon content of these soils. Depending on its local effect on soil structures, every gram of additional carbon sequestered as stable organic matter can potentially lead to the retention of up to 8 grams of additional soil water, to rebuild the 'in soil reservoir' capacity of these soils.

Given that humans substantially control whether the carbon fixed by plants is either burnt and lost or bio-sequestered into stable soil carbon to improve soil structures, our imperative is to adopt rangeland management practices that enhance rather than retard soil carbon. This can be done naturally by limiting its oxidation by fires and maximizing its fixation via photosynthesis and its bio-sequestration via microbial ecologies to enhance stable soil carbon levels.

We need to do this massively, urgently as it is the stable carbon stored in our soils that governs;

- The structure or 'sponginess' of that soil and thereby its water holding capacity.
- The Infiltration of rain and its ability to sustain water supplies for plant growth.
- Nutrient, root and microbial dynamics and thus bio-productivity, and through this,
- The resilience of those bio-systems to climate extremes and the impact of fires and collapse.

Our land management over the past 10,000 but particularly 300 years has oxidised vast quantities of carbon from our soils resulting in most of the recent increase in $CO_2$ levels to 400 ppm and marked declines in the earth's hydrological, heat dynamics and thus climate extremes. Returning that carbon back to our soils is now critical and only option to restore these soil hydrologies and limit extremes.

We can still do this practically and profitably but need urgent mass action to;

1. Extend the longevity of green plant growth and thus the level of carbon fixed from the air.
2. Reduce the incidence, frequency and intensity of wildfires that oxidise it back into the air.
3. Limit the microbial respiration of such plant biomass back into $CO_2$ and the air.
4. Increase the polymerization of plant biomass into humates to form stable soil carbon.
5. Enhance the water holding capacity and nutrient dynamics of these higher carbon soils and thus their bio-productivity and resilience in fixing more carbon from the air.

Oxley, Mitchell, Strzelecki and other early explorers independently confirmed that Australia's natural soft spongy well structured soils, or 'moulds' consistently had very high carbon levels to depth. These soils infiltrated and stored most of the rain in their deep 'in soil reservoirs' sustaining green vegetation and the longevity of growth over most of the continent even in dry periods and regions. These 'in soil reservoirs' contributed greatly to the natural resilience of the Australian landscape.

Similarly the explorers consistently described Australia's landscape as a 'park', a grassy shelterwood of widely spaced trees that would have greatly reduced surface wind speeds and the loss of water via evaporation; further extending the longevity of green growth and its ability to fix more carbon. Vegetation which still covers 95% of Australia. While only one third of it is green and growing at any one time it still fixes some 2.3 bt/an of biomass. By regenerating its former high soil carbon levels it should be possible to extend the area and longevity of green growth up to two thirds of the time. This could potentially fix an additional 2 bt of biomass per annum.

If 60% of this total biomass was converted into stable soil carbon it could sequester over 1500 million tC/an, or 1000% of Australia's current direct carbon emissions. Reducing carbon losses from wildfires over the 30 mha that is currently burnt annually can avoid a further 150-300 mtC/an or up to 200% of our emissions. While the rates of carbon fixation and sequestration by shelterwoods vary with species, ages and sites; above ground biomass yields of 10-20 t/ha/an are attainable. Over 300 mha they may sequester 300 mtC/an equivalent to another 200% of our industrial emissions.

Depending on, and at the international carbon price of $37/tC these offsets may have a value of some $78 b/an. However these financial returns are insignificant relative to the consequences from not regenerating the carbon content of the soils, their hydrology and the resilience of our rangelands and their consequent collapse as aridification, wildfires and climate extremes intensify.

This Regenerate Australia concept provides a practical blueprint for securing such outcomes from regenerating the health and resilience of 300 m ha of our at risk rangelands by;

- Reducing wildfires across the 30 mha, mostly in northern Australia that is burnt annually and prevent some 5-10 tC/ha or 150-300 mtC/an from being oxidised back to $CO_2$.
- Returning this carbon back into soils via the action of herbivores and soil fungi so that it contributes to improving the structure of these soils, their water holding capacities, nutrient dynamics, root and microbial ecologies and resilience.
- Restoring the former longevity of green growth and productivity of these soils and thus their ability to draw down carbon from the air and fix it as stable biomass and more soil carbon.

Similar opportunities exist to restore the hydrology, resilience and productivity of many other brittle rangelands globally. Our imperative is to do so urgently.

## 7. Managing herbivores as tools in regenerating the soils and resilience of rangelands.

The natural extension of rangelands across the Earth's 'brittle' seasonally dry landscapes was only made possible relatively recently via the evolution of sophisticated symbioses between the perennial grasslands able to colonize such sites and herbivores, critical to their biology, recycling and survival.

These symbioses enabled the grass to opportunistically fix carbon via photosynthesis and herbivores as mobile bio-digesters, to convert it into bio-fertilizer, stable soil carbon and protein thereby avoiding it being oxidised back to CO2 by dry season wildfires, further desertifying these habitats.

In doing so, these symbioses are able to bio-sequester large quantities of carbon into these soils to rapidly improve their structure, water holding capacities, nutrition, resilience and productivities. Through these processes, ecologically managed herbivores can serve as powerful tools to regenerate degraded and at risk landscapes and limit their collapse back to deserts via wildfires and drought.

Up to and during the last ice age vast numbers of mega-fauna browsed and grazed the shrub and grass fuels of Australia's vast areas of rangelands and helped to create their soft high carbon soils. With their extinction as late as 12,000 years ago fuel levels and fire intensities increased greatly. To survive and limit these intense wildfires aborigines would had to rapidly adopt mosaic control burning and fuel reduction strategies which resulted in the natural selection of a more fire adapted but also fire reinforcing flora of open grassy shelterwoods with deep soft high carbon soils.

While the introduction of sheep, cattle and rabbits over the past 200 years reduced fuels, their constant grazing pressures and the oxidation of the rangelands has degraded rather than restored the former mega-faunal effects and aided the regeneration of vast quantities of woody weed fuels. As these landscapes aridify control burning is becoming a more difficult and degrading option. We need to find a better, safer solution based on the natural ecological grazing and extended pasture recovery periodicities to manage our increased fire risks and regenerate these brittle dryer pastures.

Specifically Australia's 300m ha of inland and northern rangelands produce some 3bt of grass that if not eaten dries to become fire fuel that threaten the collapse of these bio-systems. To eat this grass requires some 100 million cattle equivalents, or 4 times current cattle numbers as well as the restoration of the former natural grazing ecologies in which large herds rapidly removing fuels from mosaic patches but then allow them to regenerate for extended periods free of stock.

Leading innovative graziers across Australia have demonstrated the ecological effectiveness and benefits of such grazing strategies over millions of hectares in limiting wildfires, restoring soils, the local hydrology and in aiding the natural regeneration of bio-diverse shelterwoods. The provision of additional distributed stock water has also helped protect and restore critical natural water habitats. While also viable economically, significant capital is needed to provide the additional stock water.

To justify them these regenerative grazing investments need to be viable commercially, not just ecologically and strategically. They are when we consider the value of the protein produced in the healthy maintenance and natural reproduction of the herbivores in meeting food and health needs. To sustain optimal grazing ecologies we may need to harvest some 20 million tonnes of high quality grass fed protein from the herds annually, with the capacity to harvest more in response to drought.

Reliable markets would be needed for this 20 mt of high quality beef per annum as well as the capacity to locally produce, high value, non perishable premium meat products for these markets. It should be able to provide quality **'beef for 1 billion'** at a healthy protein intake rate of 20 kg/p/an.

At a nominal market price of $10/kg, these products would have a trade value of some $200 b/an for re-distribution equitably to the Australian producers and markets partners. This potential income is more than adequate to justify the capital investment needed for the regenerative ecological grazing.

If much of this income was reinvested in regional Australia, it may generate a 3 fold economic multiplier effects that should contribute greatly in revitalizing the on farm and regional economies, employment as well as ecological health and stability of these remote rangelands and regions.

As governments obtain some 30c/$ in taxation income plus significant savings from the revitalization of regional economies, these tax incomes and savings should to well exceed any seed support that may be needed to catalyse the adoption of such ecological grazing strategies and outcomes.

While significant commercial investment will be needed to provide the stock water, restructure grazing operations on ecological criteria and locally process protein into high value meat products, these returns more than justify this investment. However certainty with regards to leases, policy and tax provisions needs to be provided to enable farmers and investors to make these investments.

Further public and ecological dividends may be able to be realized via the harvesting and control of millions of feral animals, made possible by the controlled dry season stock water network.

While the key objective of such ecological grazing strategies remains the regeneration of the natural health and resilience of these at risk rangelands and farm viability in the face of climate extremes, their ability to sustainably provide 'beef for 1 billion' may also have major global strategic benefit. Over 4 billion people will soon be concentrated into urban areas with critical protein and health requirements that can no longer be met safely by traditional local chicken, pig and fish production. The ecological means to reliably supply high quality, safe and affordable grass fed protein via the regeneration of the Earth's 5 billion hectares of residual rangelands and rehabilitation of some of the additional 5 bha of man made wastelands may have major health, social and strategic relevance.

## 8. The natural regeneration of shelterwoods to restore hydrology and resilience values.

While Australia rainfall averages some 450 mm/an, its potential evaporation exceeds 2000 mm./an. As aridification and climate extremes intensify, such hydrological deficit will impact the ecological health of many of its rangelands. It follows that we ensure that most of its unreliable rain infiltrates into its 'in soil reservoirs' and is used efficiently by plants, not lost via runoff or evaporation.

Currently over 50 raindrops out of every 100 that fall on Australia are lost by runoff or evaporation. By contrast the former grassy shelterwoods that covered most of Australia protected the soils from surface wind shear and thus evaporation. Fewer than 10 drops out of 100 naturally ran off the land.

The re-integration of such protective shelterwoods across these rangelands could help to conserve and more effective use our declining rainfall. The restoration of ecological grazing with adequate rest periods for these rangelands can be expected to result in the widespread natural regeneration of tree seedlings from seed reserves that with some management can re-form these shelterwoods.

This should enable these naturally regenerated shelterwoods to significantly enhance;

1. The hydrology of these landscapes by limiting current evaporation and runoff losses.
2. The sequestration of up to 10 tC/ha/an into soils to aid its structure and water retention.
3. The sequestration of up to an additional 10 tC/ha/an as above ground tree biomass.
4. The longevity of green growth in these bio-systems due to their conservation of water.
5. The uptake and cycling of soil nutrients from depths by the deeper tree and grass roots.
6. The palatability and nutritional value of the perennial pastures and browse to herbivores.

The re-integration of appropriate native shelterwoods into these rangelands can also often enhance the longevity, palatability, productivity and resilience of pastures and grazing outcomes as a result of the improved soils, hydrology, nutrition and shelter provided by these open dispersed native trees.

However as climates change, the most valuable role that shelterwoods may play is in restoring the natural hydrological dynamics of regions to cool them and aid their resilience to climate extremes.

These shelterwoods may also produce a wide range of valuable tree products including;

1. Timber for use on farm or for high value regional wood industries or bio-energy supplies.
2. Foliage for use as supplementary browse plant or reserve fodder in dry times.
3. Foliage for use as a soil mulch, or bio-fertilizer and soil carbon amendment.
4. A key source of nitrogen through its symbiotic fixation or via the frass of leaf eating insects. A wide range of resins, waxes, oils, honey, tannins and similar boutique tree products.
5. The restoration of habitat, bio-diversity and ecological cycling for these rangelands.
6. For some species, the production of valuable seeds for use as food products.
7. The production of valuable industrial feedstocks such as bio-diesel from seed oils.

Such tree products can contribute greatly in revitalizing regional economies, employment and social multipliers as well as generate major government savings and income. Typical ecological and economic benefits from re-integrating natural shelterwoods into rangelands can include;

**a.The production of bio-energy shelterbelts to sustain regional economies and communities.** While isolated rural towns benefit from access to electrical power, the capital cost of constructing or replacing transmission lines can be prohibitive; threatening the viability of such communities. To avoid these costs, enhance the resilience of landscapes and secure the viability of on-farm and town businesses, Narrogin in the Western Australian wheatbelt innovated to produce its own autonomous electricity via 'bio-energy from shelterbelts of fast growing mallee Eucalypts that were coppiced and converted into electricity and high value oil and activated charcoal. An advanced local scale pyrolysis plant converts the mallee woods into syngas and then electricity while the carbon that is normally emitted is retained as activated carbon, for used as a effluent nutrient filter and then bio-fertilizer. Further value is captured from the Eucalypt oils, while the composted foliage is returned to the soil.

**b.Regenerating rangelands via the accelerated succession of woody weeds into shelterwoods.** Woody weeds often proliferate on land that has been degraded impeding its economic outputs. Instead of killing this protective land cover, communities in Cobar in Western NSW are accelerating the natural succession of these dense scrubs back into natural grassy shelterwoods with 50-100 trees per hectare to provide habitat and protection. Selectively scrub species are thinned to yield a range of valuable oils, wood, bio-energy and compost products enabling the native perennial grasses to progressively form a highly productive protected understorey of grasses that are grazed. The residual Cypress pine shelterwoods sustain valuable termite resistant timber yields and an industry.

**c. The regeneration of natural shelterwoods in arid areas to provide valuable habitats and food.** Much of Australia is arid, and receives less than 200 mm rain in contrast to potential evaporation rates that can exceed 2500 mm/annum. Despite this 95% of these deserts are vegetated often via natural Acacia shelterwoods that provide critical shade, habitat, soil development and food sources. These include high yields of edible seed whose very high protein content make it a critical traditional food and now a valuable commercial 'bush tucker' opportunity. In addition to providing shelter, habitat and fixing soil nitrogen these shelterwoods yield up to 2 tonnes of edible seed per hectare, the value of which far exceeds that from conventional grain production. The regeneration of such shelterwoods creates major opportunities for sustaining communities in such arid desert conditions.

**d. The regeneration of Casuarina shelterwoods in the reclamation of degraded and toxic sites.** Nitrogen fixing shelterwoods often serve as natural pioneers in regenerating degraded landscapes. For example different Casuarina species are highly effective in regenerating unstable sandy soils, saline marshes or even acid toxic soils where their shelter, abundant neutral litter, nitrogen fixation and enhanced water retention capacities help bio-remediate and regenerate soils and landscapes. By enhancing hydrological and nutrient dynamics these shelterwoods can aid the development of productive bio-systems on soils and sites that would otherwise further degrade and erode.

**e. The regeneration of Pongamia shelterwoods for the production of autonomous bio-diesel.** Similar to casuarinas, other nitrogen fixing trees such as Pongamia millata also produce high yields of large seeds filled with oil which can be converted into autonomous local supplies of bio-diesel fuel. In addition to a wide range of regenerative values shelterwoods of these salt and drought resistant trees can yield up to 5 tonnes of bio-diesel per hectare per annum. This may have major strategic and commercial significance for remote regions, communities and economies.

## 9. Integrating the opportunistic production of grains to help regenerate rangeland soils.

With the aridification of much of Australia, growing wheat in many regions may become non-viable. Similar extremes risk global grain outputs as the degradation of soils and water resources intensify.. Key irrigated grain regions in China, India, Pakistan the Middle East and the US are running out of groundwater. Within decades billions of people may depend on our ability to grow adequate grain on marginal soils with fewer inputs and in rain fed grasslands with a dryer more variable climate.

We cant avoid these realities and risks by more inputs or plant breeding; only by more soil water. Indeed past high input practices have often degraded the carbon content, water holding capacity and thus resilience and productivity of most cropping soils, making them dependent on more inputs.

We need a new approach; one that reinforce the water holding capacity and efficient use of water in cropping soils if we are to meet future grain needs in our ever more extreme and dryer climate.

Australian farmers have excelled in doing this, refining productive, low input rain fed cropping systems on marginal soils despite their dry unreliable climates. These leading farmers are reliably securing 1-2 t/ha of grain, even on sands with less than 150mm rainfalls by regenerating the structure and resilience of soils so these can better retain and use every raindrop for viable crops.

A highly effective 'pasture cropping' approach has the potential to enhance and extend this greatly. Instead of separating animals and crops, pasture cropping uses short high grazing impacts to create 'niches' in the root zone of perennial pastures, in time and space, that provide the opportunity for the rapid growth of annual grain roots and crops, before the pasture roots again dominate that site. Due to the higher continuous root growth and their microbial activity, soils under pasture cropping can bio-sequester carbon into soils at rates of up to 10 tC/ha/an in contrast to soils under standard crops that often still oxidise and lose soil carbon, even with limited tillage and stubble mulching.

This loss of soil carbon and structure often impairs rainfall infiltration in soils under standard crops, requiring them to be fallowed for long periods thereby further impairing their structure and health. While grain yields under pasture cropping are equivalent to those on cultivated soils, inputs can be greatly reduced and grazing can resumed once the grain is harvested to bio-convert the stubble into bio-fertilizer and more soil carbon. This can greatly extend the longevity of green growth in these marginal dry grasslands and hence productivity and resilience.

In addition to sustaining yields and the reliability of securing these in most seasons with fewer inputs and lower risk, the integration of such opportunistic pasture cropping approaches can vastly expand the area of often marginal semi arid grasslands, that can be safely cropped when conditions allow.

Australia currently crops some 25 m ha annually when soil moisture allows. By integrating grazing and opportunistic pasture cropping it may be possible to safely extend the production of grain over much larger areas of existing native perennial pasture where and when soil moisture is suitable. In this way pasture cropping can be used as an ecological tool, not just to grow more grain but to also accelerate the regeneration of the carbon content, structure, water holding capacity and resilience in these at risk marginal rangeland soils, to help buffer and despite of climate extremes.

By helping to regenerate the structure and thus water holding and ‘in soil reservoir’ capacity of these marginal soils the integrated use of pasture cropping may contribute to the regeneration of some of the 300 m ha of Australia’s inland and northern rangelands at risk of degradation from wildfires and climate extremes. By opportunistically ‘pasture cropping’ even half of this land 1 year in 3 it may be possible to produce up to 60 mt/an of extra grain to help offset projected global grain shortages. Regionally this could generate some $18b/an of additional income for these graziers and croppers.

The opportunistic pasture cropping of grain legumes in these rangeland soils could generate further benefits by improving the nitrogen status and hence productivity of these soils as well as pasture re-growth and animal health. The stubble produced could be used as a feed supplement to enhance livestock production and health over the dry seasons. The grain legume crops could provide a valuable additional income source for farmers and help meet regional food requirements.

As the logistics of opportunistically growing, harvesting and exporting grain periodically from these extensive rangelands may not be compatible with those of the extensive grazing managers, they may best be undertaken by skilled specialist contractors with the needed equipment under share farming agreements with the land owners. This would enable the pasture cropping specialists to operate flexibly across extensive areas as seasons dictated using efficient specialised equipment and reduce most risks and costs for the grazier providing the land and stock for these operations.

The integration of these different specialist land uses in the regeneration of these soils and rangelands should open up opportunities for new regional and collective business relationships, innovation and efficiencies well beyond those confined by the traditional autonomous family farm. Such relationships could extend to establishing local processing capabilities to add value to specialist grain crops and result in major employment and multiplier benefits to help revitalize remote regions.

**10. Regenerating the natural nutrient dynamics and productivity of at risk rangelands.**

While most plants can obtain the sunshine and C02 they need, what mostly limits their growth is the availability of adequate water and the over 30 essential nutrients. This water and these nutrients has to be sourced from their soils.

These limitations in the availability of water and nutrients are critical over vast 'brittle' regions with seasonally dry or aridifying climates and in bio-systems on highly weathered or degraded soils. While little water or nutrients has been 'lost' from the planet, what matters is that they are available to plants for their growth and not 'locked up' in mineral forms or at depths where they are unavailable to the plant.

As such it is not the quantity of nutrients in a soil that matters, but how effectively these nutrients can be solubilised, accessed and taken up by the plant and how rapidly these can be cycled biologically for re-use by that or other plants to enhance the productivity of soils.

This is particularly critical for leached soils with low residual nutrient contents, such as most of Australia's rangelands, that naturally sustained highly productive bio-systems due to the rapid recycling of their limited nutrients and the microbial processes that drove these cycles.

Given that it is the health of these nutrient cycles, and the fungi that mostly drive them; that governs the productivity of most bio-systems, sustaining their health is critically important. Our industrial soil and agricultural management over the past 80 years has done exactly the opposite.

Indeed the microbial ecologies that govern the nutrient dynamics of our farmlands have been seriously degraded by our over; cultivation, fertilization, irrigation use of bio-cides and the heating and exposure of bare soils with fallowing. As a result their natural nutrient availabilities and thus productivity has often declined increasing their dependence on ever more fertilizer and bio-cide inputs to grow crops.

As a consequence the nutrient contents and nutitional integrity of these plants and our food has also declined, resulting in animal and human health crises and the need for more inputs.

Fortunately we can readily reverse the degradation and this 'more-on' agricultural addiction by simply not killing the natural microbial processes that governed the former nutritional dynamics of these healthy soils that produced healthy food to sustain healthy people.

We can do this simply by restoring the carbon substrates that this microbial soil life depends on and by reducing harmful inputs. In so doing we can restore the former microbial ecologies that governed the; efficient solubilisation, availability and cycling of the natural nutrients in these soils, the nutritional integrity of our food and our preventative health.

Indeed the supply of essential nutrients can often be met by simply speeding up nutrient cycles via ecological grazing and the bio-decomposition and recycling of organic wastes. The loss of nutrients can also be reduced markedly by limiting wildfires and wind and water erosion through restoring the carbon content, structure and rainfall retention of these soils and their capacity to extend the longevity and area of green plant growth and cover.

Shelterwoods of deep rooted nitrogen fixing trees can also rapidly enhance available nutrients via their fixation and solubilisation of essential nutrients from deep subsoils and their recycling of these via microbes in surface litters. Nutrient inputs can be enhanced by sustaining bio-diverse habitats that harvest nutrients in dust and provide a haven for sea-birds and insects that often import and recycle prodigious quantities of nutrients back into such rangelands.

Certainly we need to stop 'mining' rangelands for their limited nutrients via farm outputs and need to return such nutrients to our soils by recycling on farm and urban wastes. Bio-fertilizers can help return essential nutrients from urban food and organic wastes safely and economically back into our soils. Key nutrient deficiencies in some soils can be addressed via natural mineral or rock dust amendments or even known industrial residues, from which specific microbes can selectively release the essential nutrients.

As in nature, the regeneration of these microbial processes to enhance the selective solubilisation, availability, uptake and cycling of essential plant nutrients, is now critical to restore and sustain the productivity and resilience of Australia's at risk rangelands. There is no other realistic option available for the 300 mha of marginal degraded rangelands, given the high cost, degrading consequences and non viability of subsidised fertilizer inputs.

Just as nature creates and sustains highly productive bio-systems, such as rainforests, on very marginal soils and in extreme climates such as sand dunes, we too can understand and bio-mimic these natural microbial ecologies to regenerate healthy farm and rangelands.

As the availability and affordability of industrial energy, water , nutrient and bio-cide inputs becomes untenable our agriculture, food production, social stability and health will again depend fundamentally on the health of our residual soils. While we have the knowledge means and imperative to regenerate these soils and sustain our health and future, to do so requires change. Whether we will change in time to regenerate the bio-systems we depend on via these natural processes remains uncertain but we can be confident that nature will again use these same processes to restore healthy bio-systems and its stable climate even without and after our collapse.

**11.The revitalization of regional communities and economies by regenerating rangelands.**

The health of every nation depends ultimately on its, or somewhere else's ecology. All life and the health and survival of all economies, societies, communities and individuals similarly depend on this ecological health and its ability to sustain key processes and their outputs in the face of physical extremes and changes, that they may not be well adapted to or survive.

It follows that we need to understand the extremes and changes that our bio-systems is likely to be subjected to, their likely consequences and risks and how we may be able to reinforce the resilience of our bio-systems to buffer and survive these changes by regenerating the health of that ecology and the bio-systems we depend on fundamentally.

Archaeology is littered with the detritus and dust of civilizations that lacked this wisdom. More tragically, civilizations that had this knowledge and due warning but failed to act on them in time. Given our reality, knowledge and warnings we must give strategic priority to regenerating the health and resilience of the soils and bio-systems that we all depend on. These priorities must drive effective grass roots action urgently.

As is clear from this analysis, this action has to be based on the regeneration of the health of our soils; as it is our soils that are the foundation of our terrestrial ecology and the critical carbon, water, nutrient, microbial and climate dynamics we all depend on.

More importantly regenerating our soils and bio-systems are effectively the only means we have had and have to influence these fundamental global processes and balances, either via their degradation to create our imperative, and now their regeneration to address it.

As President Roosevelt warned; 'A nation that destroys its soil, destroys itself'. As we know this our priority must be to provide practical means to do this urgently, in each nation and globally via local grass roots action for each; metre, farm, bio-system and region.

While it needs national political leadership and strategic champions and coordination, the regeneration of our soils and landscapes must focus primarily on farmers and giving them the incentive and means to do it commercially in their own and humanities self interest.

Similarly priority needs to be given to empowering regional communities to support and provide critical mass and markets for these local farmer initiatives to create and capture the benefits from them and to make them commercially viable, compelling and self sustaining.

Given these close regional ecological, economic, community and farmer interdependencies, potential synergies and the scale of the regeneration challenge, Regenerating Australia needs to involve a sequence of commercial actions including;

1. Regional community recognition of and commitment to the challenges they face.
2. Community accord on the values, performance measures and outcomes needed.

3. The collation of all relevant knowledge, local experience and skills to address it.
4. The detailed planning of commercial action strategies for each interested farmer.
5. Implementation of each farm plan with relevant mentor support where needed.
6. The documentation of outcomes and benefits from each regenerative action.
7. The coordination of regional supply chain support and cycles to assist in this.
8. The coordination of regional processing, preservation and value capture capacity.
9. The coordination of direct market relationships for regional product.
10. The differentiation of regional products to optimize their value capture.
11. Longer term strategic and succession planning on farm and for regional industry.
12. Optimization of regional value capture, revitalization and multiplier benefits.

While the above sequence of on farm regeneration and regional revitalization actions need to be commercially feasible, self funding and beneficial, implementing such a transition may challenge many farmers and communities given the current impediments they face from;

1. Land systems that are degraded with declining productivities and resilience values not being able to cope with the projected increased climate extremes.
2. Conventional management practices that dont perform due to high input costs, of up to 40% of gross income, that make the on farm activity only marginally viable.
3. Risks levels that increase due to climate variability and extremes and less buffering via soils resulting in up to 3/5 crops failing instead of the 1/5 previously.
4. Value shares that decline as farmers are squeezed into just growing commodities for agents for some 10% of final market value without other individual options.
5. Rural debts of over $75b or $0.6m/farmer that become prohibitive to service and cripple any options to invest in critical changes via on farm or debt based capital.
6. An average age of farmers of 60 with low farm viabilities and high debt levels that restrict family succession planning and the opportunities for innovation and change .
7. Governments that give priority to other industry sectors now that agriculture is some 3% of GDP and engages 2% of the workforce often with marginal conditions.
8. Governments that appropriate ecosystem services and natural capital values such as water from farmers as free public 'goods' without paying for their provision.
9. Governments that continue to subsidize other industries and services such as energy and health, thereby negating fair market prices for carbon or quality food products.
10. Rural agencies that fail to address such strategic challenges and focus on overheads and sustaining their status quo subsidised incomes, positions and activities.

Despite these formidable impediments the need to regenerate the health of our soils and landscapes via the revitalization of viable on-farm and regional ecologies are now so strategically and existentially fundamental that they need to be seen as a national priority.

## 12. Realizing its potential to deliver outcomes for Australia and globally

The above outline of why we must, and how we can, Regenerate Australia via innovative commercial grass roots and regional actions confirms that we can address our pending physical and social crises.

That Australia, while in the front line of expected climate extremes and impacts, also has unique strengths in its natural adapted bio-systems, innovative farmers and confirmed practical options in regenerating resilient, productive landscapes able to respond to and benefit from these extremes. Our challenge is to stop impeding such innovations and catalyse action to realize their potential.

This proposal to regenerate 300 mha of rangelands in inland and northern Australia at most risk and in the front line of locked in climate extremes seeks to provide an outline of how this can be done. While the actions are detailed as a logical sequence of component activities, initially to limit wildfire impacts, as in nature they are all elements of one holistic, synergistic regeneration strategy. None of the components is optimal nor viable in isolation. Collectively they all cross-reinforce one-other.

Details on the technical design, scientific basis, economic substantiation, practical implementation and commercial value capture opportunities from these strategies can be provided. However of most immediate importance is to foster critical public and policy debate on the need for such actions so as to drive national policy acceptance and their grass roots commercial implementation, in time.

The simple ecological reality is that the bio-systems we all depend on are at risk from wildfires under pending climate extremes and need to be constrained urgently. We can do this safely and naturally by regenerating the ecological processes and balances that we have degraded to increase this risk. The down side is that we may have less than a decade to initiate the needed practical actions and widespread changes before pending climate extremes and fire risks impede our ability to do so.

### Policy priorities to catalyse the needed on farm, regional and market opportunities.

While the above actions have been designed to be commercially viable and self sustaining, public policies must not impede the on-farm strategic investments or their implementation, but provide;

1. **Clear strategic leadership** to outline the reality we face, the consequences our options and to articulate a vision and 'blueprint' of what needs to be done, how and why.
2. **Certainty as to policy settings** and commitments so that farmers, regions, industry and markets can have the confidence needed to make major strategic investments in change.
3. **Incentives** to make the needed investments particularly the removal of the wide range of subsidies, regulations and externalities that protect the status quo and distort valid markets and prices for the critical new products and values delivered via these innovative changes.
4. **Information** on the scientific, economic and practical feasibility and viability of the new options and via practical training and support on their tailored local implementation.
5. **Innovation support** to help refine, substantiate and commercially extend these innovative technologies, methods and opportunities so as to drive wider change and secure outcomes.

Provided limited catalytic support is provided and key policy impediments are reduced, the evidence is that major commercial on-farm, regional and strategic dividends can be realized.