Protecting farm animals during drought, protecting livelihoods: the bases and value of preventing and mitigating disaster risk in cattle: A case study from Chihuahua, Mexico following the 2011 drought.

Key words: Drought, beef cattle, mitigation, ejidos, livelihoods, construction of risk.

Introduction.

Drought is a particularly insidious form of hazard that affects increasing areas of the world and its animal populations, particularly cattle. More than a billion people worldwide depend on farm animals for their livelihoods and wellbeing (Sawyer and Huertas, 2018). Many occupy hazard prone areas where recurrent, frequent, small scale and less frequent large-scale disasters occur. This is mostly true in countries in the global South, particularly affecting poorer farmers and their families.

Chihuahua State in the north of Mexico has a total population of some 3.6 million persons. The State has the fourth most rapid rate of urbanization in the country. But, 70% of its 250000 square km. is under animal livestock production, and farming is an important economic activity and source of employment. Livestock production is dominated by beef cattle and to a lesser extent milk cows, followed by sheep, goats, chickens and others. Sixty percent of the land used for cattle raising, much as livestock for export and fattening in the USA, is under private ownership. Fourty percent is controlled by ejidos, under communal property rights, and where communal grazing is prevalent (OECD, 2012) (the ejido is a traditional form of land holding raised to modern prevalence by the 1917 Mexican Revolutionary Constitution and typified by both assigned indivual and collective, common usage).

In general, privately owned land is well managed for cattle production, has modernized over time, is competitive in US markets and has suffered little during recent droughts. This is not the case with ejido based production. Beyond the impact on animals and their welfare, drought stresses poorer livelihoods and seriously affects their sustainability. This has serious effects in terms of poverty and it's attendant social, economic and political consequences, including migration and loss of futures.

Although drought occurs "naturally" due to normal variance in meteorological and hydrological conditions, stress associated with anthropogenically induced climate change and many other more localized social practices is of equal concern. In rural areas in Chihuahua, degradation of local ecosystems due to inadequate rotation of cattle and overgrassing, along with depletion of local aquifers due to lack of control over the rate of extraction, increase the stress on livelihoods as they lead to lack of fodder and water. Solving the problem of "drought" thus goes way beyond the problem of a periodic reduction in water availability during dry periods and requires a consideration

of the influence of culture, custom, common land useage rights and their influence on ecological degradation and animal rotation and foddering, economics and governance factors.

The present study considers drought affectation among beef cattle in Chihuahua and its impacts on people and their livelihoods, in particular, with regard to the historical drought of 2010-12. This provides a background for a detailed consideration of World Animal Protection's-WAP- actions on the Aldama Ejido to mitigate losses during this drought and prevent future loss during any new drought episode (see Map 1).

Although one central concern of this document is the economic cost-benefit arguments in favor of prevention and mitigation of cattle loss, the discussion and arguments presented here cover far wider contextual concerns, dealing with livelihoods, the nature of, and problems faced by the export cattle industry and public policy relating to drought and ejido based livelihoods.

The document is structured in the following way. A first section deals with the export cattle industry in Chihuahua, its problems and challenges, opportunities and returns. The second section briefly examines the problem of drought in Mexico and in the northern state of Chihuahua in particular, its tendencies and causes. A third section examines the 2010 to 2012 drought and its impact on the cattle industry in Chihuahua and on Aldama herders. A fourth section outlines the WAP approach and support to disaster risk prevention and mitigation in Aldama. The final section summarizes the benefits of the actions and their cost ratio, considering challenges and difficulties in such measurement. This is based on a study contracted by WAP in 2015. Concluding remarks are offered as to the future of the ejido based cattle industry, the mitigation-prevention-response equation and future socio-economic evaluation of drought risk prevention and mitigation.

The meat cattle industry in Chihuahua.

Chihuahua accounts for some 4.9% of Mexican beef cattle and 9.1% of dairy products (OECD, 2012). But, it accounts for over 30% of cattle exports to the USA, its nearest and most accesible market. Chihuahua and the USA share some 450 km of borderlands. Most beef cattle are raised on Chihuahua's high, dry plainlands (between 1200 and 1600 feet) which are reliant on rainfall for plant regeneration, suffer very hot summers and very cold winters. According to Ortega-Ochoa et al (2008), 18 million ha are used for cattle farming.

Cattle numbers varied greatly over the 20 years prior to the 2011 drought and during the drought years. From 2 million head of cattle in the early 1990s the numbers dropped to near to a million in 2000. By 2008 the numbers had grown again to near to 1.8 million as the drought receded from the beginning of 2000 onwards.

Much of this variance may be explained by farmers responses to drought and non-drought conditions and their impact on cattle exports, down sizing and later increase

in the size of herds. Cattle are capital and wealth for poorer ejido farmers and opportunity for the richer private sector and although herd sizes are decreased during drought for numerous reasons, once the rains return herd sizes increase. Thus, cattle exports increased by 63% in the hard drought years of 1993-94, including heifers. Downsizing of herds was due mainly to financial burdens and debt incurred by farmers. In 2009, pre-drought, the Mexican Ministry of Agriculture, SAGARPA, put the number of cattle exported at 335000. By 2010 and the beginning of the drought, the number was 480000 and by 2011, 580000. In 2012, some 450000 cattle were exported to the US for a value of 218 million dollars.

The value of cattle in the US is double that at home in Mexico thus offering a strong incentive for exports. Producers aim to sell calves at 11-13 months and the average value of cattle exported to the US is 470 dollars. Estimates suggest that 75% of exported cattle weigh between 300 and 450 pounds. Exports concentrate on cows for fattening on feed lots in the USA. During drought years the average weight of cattle, especially those from ejidos drops considerably.

Regarding the ups and downs of cattle numbers and exports, Ortega-Ochoa et al (2008) have discussed the different factors that affected this movement during the drought years of the 90s. Thus, between 1994 and 1996, the cow/calf operation was severely affected by the drought, low cattle inventories, low conception rates, high mortality rates, high maintenance costs, and low cattle prices. The situation was worsened by the financial crisis of 1995 and 1996, when interest and inflation rates reached their peak at 40% and 35%, respectively. This further reduced profitability by increasing operation costs. These conditions many times lead to selling off and increased exports during drought. Such a play of factors also existed in the 2010 to 2012 drought.

Drought in Chihuahua: climate and social practice

Drought is endemic in northern Mexico, including Chihuahua State, where desert conditions are also prevalent. Historical records reveal intense drought conditions over the ages in many parts of Mexico during the Colonial, Independence, Revolutionary and modern periods. It is hypothesized by some that the Mayan and other civilizations disappeared in Mexico due to drought.

The 1956-1957 drought that mainly affected the northern border states of Tamaulipas, Chihuahua, Coahuila and Sonora, but extending to Sinaloa, Durango, Zacatecas, Colima, Aguascalientes and even the southern state of Oaxaca, had significant social effects causing unemployment and migration. During the last decade of the twentieth century extreme drought was experienced in Chihuahua and Sonora. Even though the effects were devastating in those states and their vicinity, they didn´t affect the rest of the country. Some irrigation districts suffered because the water stored in dams were used during the drought period until they were almost empty by 1994.

Concentrating on the 1990's period, Ortega-Ochoa et al (2008) have observed that the drought cycle extended for more than a decade without relief, following a wet winter in 1992. The least amount of precipitation occured during 1994 and 1995. This drought complied with all the established definitions of this condition: low recorded precipitation; low soil water content; reduction in surface and underground water storage and reduction in society's well being due to water shortage.

Despite the clear "natural" drought proneness of the Chihuahua area and the observed increase in this parameter over the last decades, anthropogenic factors are equally important in terms of fodder and water availability during drought years. And these clearly mostly affect ejido based herders.

A number of studies (see Ortega-Ochoa et al, 2008 and OECD, 2012, for example) provide evidence and information as to these anthropogenic processes. The principle factors mentioned in these studies include a severe loss of biomass over the years due to overgraising (between 1978 and 1996 biomass production in shrublands and grasslands declined by 52 and 42 percent), loss of adequate regeneration of suitable and nutritional plants following meteorological drought, lack of controls over the use and extraction of water and economic subsidies lowering the costs of electricity for water extraction, using pumps. High levels of erosion and gullying and extreme environmental degradation ensue. The OECD study (p 221) comments that: "poor farm management practices can easily make a bad situation (caused by low levels of precipitation) worse by reducing soil capacity, making land harder to work, and reducing moisture availability…poor pasture management is endemic…overgrazing leads to elimination of desired plants and the domination of inedible plants or to no vegetation…rains then cause major erosion problems that make pastures less productive and increase difficulties in managing cattle" .

0vergrazing and over stocking of ejido lands, with a lack of culling and adequate management of herd sizes during drought, plus inadequate rotation of herds on existing pastures, is basically a response to the lack of private ownership of communal grazing lands and incentives to invest or manage these rationally. This combined with the fact that the capital base of ejido herders is essentially the cattle themselves and not the land (as is the case with private landowners), has significant impacts on practice and herd sizes.

Firstly, no collateral is available to ejido herders beyond the cattle themselves. This makes access to bank loans and finance to improve farming practices almost impossible. Although the government gives loans to ejido farmers if they invest in land improvements this is many times used in an "atomized" and uncoordinated way. Secondly, herders are unwilling in general to cull herds and release pressure on pastures due to the very fact that their cattle are their only real wealth. The ideological and cultural value assigned to the ejidos since their creation with the Mexican Revolution and it's 1917 Constitution, makes reform and change difficult and for many

condemns ejido farmers to vast difficulties in raising productivity, modernizing and increasing living standards. This is the situation faced by organizations and institutions searching to provide support prior or during conditions of extreme meteorological drought.

In summary, the OECD study indicates that small farmers (mainly ejido based) in Chihuahua are typified by: a limited land base; inadequate land tenure rights; location on marginally productive land; limited access to productive land; limited access to capital; lack of access to advanced technology; limited access to off farm incomes.

Thus, beyond mitigating meteorological drought itself, prevention and mitigation of the causes and impacts of drought must resolve the aforementioned anthropogenic causes. Moreover, further complicating the situation, it has also been suggested by some that problems for herders relate more to politics, bad governance and US manipulation of prices for cattle at the border than drought itself (see Economists at Large, 2015)

The 2010 to 2012 drought in Chihuahua and its impacts on ejido herders.

The 2010-12 drought which affected more than 15 Mexican states and 80% of the national territory, has been described as the most severe in Mexico's recent history and has also been seen by many as a clear sign of climate change. Rainfall was 25% below the average during 2011 in Chihuahua the fifth driest year on record according to Arreguin Cortes et al. (2015). Adjustments and planning for future droughts is required since long-term data indicate that drought is the rule, and not the exception, for all of Chihuahua's rangelands.

Combined with a particularly cold winter, with minus 12 degrees temperatures, the drought, along with anthropogenically induced fodder and water shortages put the cattle population in Chihuahua under severe stress. Although data varies, WAP estimated that up to 350000 cattle died while the OECD study talks of 250000 and a five-fold increase in slaughtering. Other sources have talked of numbers ranging upto 600000. Clearly data are not easy to come by in a reliable fashion.

Pasture capacity was reduced from a carrying load of one cow per ten acres to a staggering 30 acres per cow. Only some estimated 10% of herders did anything more than rely on ancestral practice to resolve problems. The advanced average age of ejido herders has not helped in terms of technological change and modernization. Destocking, although practiced by some was unsuccesful and ejido farmers generally held on to their cattle awaiting rainfall. Mass selling and one-off selling were also practiced by some, as was the selling of land to larger farmers to raise capital. Both processes led to loss of future opportunities and severely affected livelihood sustainability.

Government put in 250 million dollars in the short term. A hundred and fifty wells were authorised but only 50 were built. Ironically, the Federal Government reported that the

number of requests from states for funding for disaster risk reduction initiatives during the drought was negligible compared with the requests from the same states for emergency relief funds when faced with droughts, flooding and hurricanes. The knowledge that government will help with emergency response actions leads to much apathy and lack of initiatives for change and the arrival of remittances from the US only adds to the lack of incentives to take risks and improve methods. A cycle of poverty is created among collective herders (OECD, 2012)

The WAP intervention in favor of the prevention and mitigation of cattle loss.

As a prelude to a consideration of the WAP intervention in favor of reduced drough disaster risk in the Aldama district and ejido during the 2010-12 drought, a few lines are warranted on the evolving government policy towards drought in Mexico and the search for greater prevention measures.

Most analysts (see Arreguin Cortes et al, 2015 and Lopez Perez, 2017, for example) see a transition in policy formulation with the occurence of the 2011 drought and its most severe impacts. Prior to this most policy was guided by reactive management principles and support for the emergency and recovery stages following drought impacts.

Arreguin Cortes et al (2015) state: "The only policy in place to deal specifically with drought (prior to 2012) involved two mitigation funding mechanisms: the National Fund for Natural Disasters (Fonden), that has specific rules that include assessment of drought effects during December at the beginning of the dry season, and the Attention Component for Natural Disasters for the Agriculture and Fishing Sectors (Cadena- a system for reinsurance). Both of these funding mechanisms depend upon predetermined set levels of stress taken from the Streamflow Drought Index (SDI), and the Standard Precipitation Index (SPI)".

With the 2011 drought affecting more than 15 states, a clear trend towards a greater spatial coverage of drought with each succesive episode in the country and the debate on the impact of climate change, the federal government reacted with the implementation of a presidential decree in January 2012. This organized several intersectorial programs within the federal government to deal with the 2011 drought. A two-tier approach was defined: one set of measures aimed to protect production and infrastructure, and another provided humanitarian help to families and communities affected by the different levels of drought. The humanitarian component included: water and food for affected communities and family income protection; the productive component incorporated: temporary employment in affected areas, insurance protection for lost crops and livestock deaths, maintenance of production capabilities, financial support for economic activities in affected areas, and finally sound and sustainable use of water. Regardless of the collaboration between state, municipal and federal governments, and the coordination of at least five ministries and three other federal offices from the federal government "***the approach was undoubtedly reactive, and showed its limitations, therefore new ideas began to be considered to tackle***

future events in a more proactive and preventive perspective" (Arreguin Cortes et al, 2015).

The drought coincided with the change of national government in Mexico and the arrival of Ernesto Peñas Nieto to the Presidency. Immediately steps were taken to reform the drought policy and encourage more preventative actions for the country. The creation of PRONACOSE, the National Programme to Combat Drought, was followed by the creation of a multi sectoral drought committee and the promotion of mitigation plans for the countries water basins.

Identification of priorities and needs took place over the period 2012 to 2015 when Arreguin Cortes et al published their review of the new paradigm. This concluded that a considerable slow down had taken place between 2012 and 2015 as the drought ceded and rains returned, and all went back to business as usual. This they described in terms of the observation by Dennis Whilhite (2011), a well know North American drought expert, when he talked of the "Hydro-illogical cycle", or what Mexican government officials referred to in the local press as the "common amnesia syndrome". Thus, cattle ranchers suffering the drought for years would immediately go into cattle buying frenzie as soon as the rains returned, regardless of the prognoses for more dry spells and drought in the future.

During the period 2012 to 2018 Mexico also faced other types of hazard of much greater social concern, such as the continuing hurricane impacts and the two very serious earthquakes that affected the country in 2016 and 2017. These served to guide attention away from drought and its short to longterm effects in favour of attention to more rapid onset events and their consequences. All suggests that the maxim of "striking while the iron is hot" holds here and that the opportunities for mitigation and prevention of drought do not last long. Precisely because of this, the need for more study of prevention and mitigation and their cost benefit value are called for.

In early 2012 Mexican news media reported large number of cattle dying in the fields with their mouths full of thorns from the cactii the animals tried to eat to survive. This was the trigger for WAP to undertake a disaster needs assessment amongst Chihuahua ejidos, examining conditions in 3 districts-Aldama, Ojinaga, and San Francisco (see Map 1), estimating over 30000 cattle affected, 70-90% of the herd in these districts. An estimated 12500 cattle had died according to WAP. This and knowledge of the non-drought drivers of disaster risk led to the conclusion that intervention should concentrate on land management practices in ejidos, going beyond immediate disaster response mechanisms and promoting better practice to reduce risk in the future.

The WAP actions are a case of disaster induced, post impact improvement of herding conditions and reduction of risk, searching to contribute to herder's livelihood sustainability in the future. According to a summary of the action (WAP, 2014.) this constituted "an innovative and effective response that considered both animals' and

peoples' needs and demonstrated how integrated planning can rebuild and strengthen community resilience".

Two hundred and twenty families were assisted and 2500 cattle, equivalent to an investment of 273 dollars per family and 24 dollars per cow. The intervention consisted in three stages.

Firstly, emergency relief assistance costing 3000 dollars and concentrating on mineral feed blocks and organization of a local disaster committee.

Second, on land and water management for 41680 dollars. Two wells and a borehole were built; indigenous cactus, plants and hybrid pastures (Triticale sp) rich in protein and resistant to low temperatures in the winter were planted to provide for feed in emergency and seeds to replicate further planting were offered; parts were provided for and expertise offered on water pumps; advice and financial means were provided for the construction of small sand dams based on models seen in north Kenya, and support for the building of two permanent dams by government and the road access to this were promoted. A secondary effect of this action was that wildlife such as deer and smaller mammals that had not been seen for much time came back to drink.

A third stage covered research and awareness building and capacitation in water and land management for sustainable solutions working with the University of Coahuila on a cacti project and with private consultants on aquaponic systems and training at the University of Sinaloa.

As part of the awareness efforts that sought to influence public opinion, WAP organised a video contest among three local schools that promoted responsible water consumption. Over 130 videos were made. With regards to sustainable solutions WAP championed the "holistic" management of pastures and built and installed 3 aquaponic systems to grow high protein forage, vegetables and tilapia, with a maximum recycling of water.

The 2012 support led to a proposal for continued action in the future covering the same three stages as in the ongoing action: relief, environmental improvements and land management and technology transfer. The total sum planned for was 170000 dollars, or 44000 per year over the Project life. Following this, in 2015 WAP commissioned the development of a risk map for the Aldama ejido and the associated risk assessment was then aligned with the governments risk Atlases, to allow local authorities to understand and manage their lands better, and to facilitate applications for risk reduction federal funding.

WAP concluded from their experience that there was evidence that disaster risk reduction planning that integrates the welfare of animals and the people who rely on them can: reduce the effects of future disasters, protect livelihoods, the economy and

social wellbeing, decrease animal loss and suffering, increase the participation of citizens, thus increasing a community's ability to cope without government or NGO interventions using the most innovative thinking from across different fields of expertise.

Cost benefit analysis and the promotion of drought prevention.

As part of the analyses undertaken on needs and actions, the justification of drought reduction actions using cost benefit and other evaluation processes was recommended in the PRONACOSE process**.** Arreguin Cortes et al 2015, also argued that risk management needs to be evaluated based on quantifiable impacts, having access to data bases and models that will help us estimate how much money, resources, and lives are saved by using this approach rather than just reacting to drought crisis.

Such calls for analysis were taken up on by WAP for its Aldama operation and the organization contracted Economists at Large-EAL- to undertake such a study in 2015.

The EAL study was based on the cost sum of 60000 dolars invested by WAP in benefitting 220 families and 2500 beef cattle on the Aldama Ejido. Recognition was made from the start as to the difficulties associated with cost benefit analysis and drought. No comprehensive economic assessment of the impacts of the 2011 drought conditions in Chihuahua was available. Data on losses of livestock were also hard to come by for the EAL team. The difficulty of clearly establishing a beginning and ending point for the drought episodes, the large spatial coverage involved and the intervention of other social and economic, political and institutional factors in affecting animal and human welfare and livelihoods in the future, were also amongst the problems faced. Moreover, as the calculations assume that animals will be saved or better maintained in the **future**, providing more favourable market or capital accumulation conditions, investment in mitigation is full of uncertainties as to outcomes until the next drought does in fact occur. If this should be in the medium term the chances that multiple other factors will have intervened in the meat industry is also great.

In addition, the response of cattle farmers to drought is uncertain. Many sell off cattle to realise earnings but in doing this, especially when it is heifers, future stocking and opportunites for calf production and earnings are reduced. Finally, EAL pointed out that many farmers may just wait for government to offer help once the drought terminates—a survey by WAP revealed that 62% of herders intended to do exactly that.

For all the above reasons EAL determined that it was only posible to suggest potential benefits from the intervention as opposed to clearly attributed gains.

The 'face value' calculation of costs was in appearance, simple—60000 dollars or 24 dollars per cow. Benefits could be expressed in terms of the future market price of saved cows and the possibility to gain this value. But there is more to this and the notion of benefits than meets the eye as we will discuss later in our concluding remarks.

Market value of the cattle in the future was conservatively put at 170 dollars by EAL, half the real actual value of 340 dollars. With this the value of the 2500 cattle was 425000 dollars, as opposed to the higher value of 850000 if total current value was used. Thus, in theory for every dollar invested in mitigation by WAP, a savings of between 7 and 14 dollars would be achieved, according to the lower or higher values attributed to the cattle.

Faced with the problems of economic analysis EAL recommended post evaluation monitoring of a small number of herders over time to analise the workings of micro economic factors on the value of herds.

Concluding remarks

Drought is endemic in Chihuahua. Climate change would seem to be increasing the hazard over time. Difficulties for herders come not only (and maybe not principally) from "natural" drought but rather from human encroachment on fragile ecosystems- more herders, more animals- inadequate land use practices and bad water management. Such factors, combined with uncertain market conditions and reactions from US government and buyers, compounds drought conditions and puts the industry under stress. This is so mainly for ejido based farmers, operating collective lands with little capital and no collateral and difficulties in modernizing.

Erratic behaviour during droughts with down sizing of herds, over grazing, lack of water management, amongst other practices, and basically conservative responses to drought, have put the ejido based industry under continuous exposure and jeopardy, not so the large capital intensive privately owned farms. Uncontrolled increases in cattle numbers when conditions improve helps little in fostering adequate cow to pasture ratios. Greater and more responsible capital investment will become even more important with climate change and adaptation needs. And, if the ejido is to be successful, more adequate collective, municipal based management of land, graising rights and processes and water accessibility is required. It is not at all clear that with public lands and public processes this is at all possible.

Given such contexts and needs it may be asked if many ejido farmers can survive and succeed in an export market medium, as opposed to producing for self sufficiency? Especially now the border is a more closed route than before with new Trump regulations and controls over trade and movement. A response to such a question should obviously influence the type of approach to support for ejidos and for mitigation of drought risks.

The WAP intervention was based on an adequate analysis of needs—land and water management and training as opposed to humanitarian response. And it is highly probable that benefits will accrue to the farmers covered by the actions. No post investment analysis has been undertaken to date it seems. But the greater question is if ejido farmers have a future beyond their reliance, during times of stress, on government and outside help. Are there other livelihood sustenance alternatives, how can

ecosystems be given a chance to recover, who would support such actions? And in the case of cattle raising for export given that only larger units with good collateral and a solid asset base can survive and compete, how can the ejido based farmers consolidate production and collaborate in terms of cattle numbers and pasturing practice?

Beyond these basic questions there is also the question of the value of inmediate or short-term cost benefit analysis as undertaken for the Aldama ejido. Although the equation is relevant and logical, is this the way to measure costs and benefits when there are more and equally significant factors than simple economic gain and survival in play?

Observations seem to point to the fact that using longer-term analysis is the only way to capture micro-economic behaviour and the real impact on development prospects. Livelihood maintenance in general, the ideological and historical role of the ejido in society, themes such as the avoiding of off farm migration and the futher swelling of cities and impacts of retention of populations in rural areras on crime and violence etc may be other benefits that accrue to a subsidised ejido based drought prevention and mitigation program. But these need other multi factor approaches to evaluation that go beyond cost benefit and touch on social cost benefit equations.

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