Impact Assessment of Azolla for Animal Husbandry
It’s an ongoing work of documentation and learning from the Thar desert while introducing and promoting Azolla for livestock promotion.

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The project team, namely Aakriti Srivastava and Rajendra Prasad, did data collection.

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Urmul Trust, Year 2017
I. Executive Summary:

In order to respond to the adverse impact of climate change on livelihood and sustainability for those in the farming sector of the Indian Thar desert, Urmul with the funding support of Oracle, envisioned developing an arid zone organic farming model to promote in western Rajasthan, and ultimately integrating it with existing non-farm models to achieve a comprehensive livelihood ecosystem design for the region. The promotion of azolla as livestock feed forms a significant component of this initiative.

The purpose of the study was to conduct an impact assessment of promotion of Azolla during the phase 1 of Urmul Farm intervention in the year 2016-17 in order to facilitate promotion Azolla as a sustainable, economical and high value source of feed for livestock in the desert regions.

This study concludes that Azolla is a viable alternative for livestock feed with possibility of diversification into other areas. There has been a positive response towards azolla; the use of azolla has permitted improved health of livestock and increased milk production that enables increased monetary benefits, and can also lead to significant decreases in cost of livestock feed. People have also been able to increase their quantity and quality of milk consumption for their families. The biggest benefit is the increased plausibility of financial security in the next year, which is a great step forward towards sustainable livelihoods and provides scope for expanded use of azolla in other fields. In fact, although a small proportion, but the survey demonstrates that interest in diversifying azolla use has already begun and the farmers are taking a keen interest in potentiality and possibility of alternative agricultural production with azolla playing a significant role. Thus, azolla emerges as a viable and sustainable alternative that is both economically feasible and environmentally sound. The study recommends that the intervention and impact assessment continue next year.

II. Problems in Current Agricultural Practices and Need for Farming based on Organic Principles

There are various factors that are affecting the local agricultural practices. These dynamics-some negative while some positive- are eventually leading the entire discourse to an inequitable opportunities model in agriculture and allied sectors promoting innovation.
a) Increased dependencies on outside Markets and inequitable growth

Agriculture techniques adopted and the market patterns have changed drastically leading to a greater inequity in the market. The local produce is not consumed locally. High incursions of cash crop produce have changed the markets and its demands. Irrigation and yield-increasing techniques (read pesticides, BT seeds, etc.) have improved the production capacities of farmers- but it is limited only for those who could afford heavy investment solutions. The small holding farmer is still fully rain dependent. Amidst all this, the return on investments has decreased, diminishing the profit margins of the farmers. The farmers have become heavily dependent on ancillaries and have become extremely vulnerable to market fluctuations. Capital-intensive investments have negatively affected the value of money and have caused high inflation and instability in the markets.

b) Ecological Depletion

The other flipside of the boom in the agriculture is the unrequired and disproportionate strain it has created on the natural resources. Excessive harvesting has depleted the soil quality of an already poor quality land, to dangerous extents. The excessive tube well based irrigation has depleted the underground water levels to extend of vanishing natural sources. Almost 60% of the blocks of the state now come under dark zones for ground aquifers. The dependence on the chemical fertilizers and pesticides is also increasing resulting in further imbalances. This, overall, is resulting in high inefficiency of the system and wastage of the resources as well as the opportunities.

c) Privatization of Public Commons

The wide scale land privatization has led to the dismantling of common pasturelands and community forests and groves. The acquisition and redistribution of the ‘village commons’ have deprived many poor households who were earning around 15 to 20 % of their income from these. The arable expansion has swelled but is not enough in proportion to the number of people who have been struggling to make a living off annual crop cultivation. This arid region can barely support agriculture for one season, surmounting the pressures on the families. To increase the arability, the land is subject to many inorganic and chemical treatments. It is this intensified and excessive cultivation of the desert that has led to widespread destruction of agricultural soils leading to land infertility and increasing desertification. This has severe impacts on the availability of common pasturelands for desert livestock. A practice evolved and sustained for ages is now at a critical risk.

d) Lack of balance of Traditional and Modern knowledge, techniques and solutions

Though illiterate, the traditional and indigenous knowledge of rainwater harvesting, agriculture and land was vast in the region. The recent years, with the boost of governmental efforts and
market dynamics, there has seen a substantial increase in the numbers of formally educated. However, this increase has corresponded in gradual decrease of the indigenous knowledge amongst the youth, who are now improperly trained with modern techniques. This increased dependency on modern approaches but improper preparation and lack of appropriate tools is causing loads of wastage in the system across the spectrum- ranging from farming, irrigation, and distribution to the procurement and services for upkeep.

III. Project intervention: During the phase one of the project in 2016-17

The Organic Farming Initiative: Development of a self-sustainable ‘off-the-grid farm and extension enterprise model’ for Thar Desert

‘Show people what alternate is possible, link them with those who are doing it, provide them support to do things their way and they will develop their own sustainable solutions’

To respond to the newer challenges emerging in the farming and livestock sector, Urmul with the funding support of Oracle, envisioned developing an arid zone organic farming model to promote in the western Rajasthan, and ultimately integrating it with the existing non-farm models to achieve a comprehensive livelihood ecosystem design for the region. This aims at further expansion into enterprise development. This way it covers food, fodder and ecosystem security for the region.

To systemically design the response, Urmul started with one of the any campuses in the region. The Urmul campus at Bajju has been taken up to be developed as a demo organic farm to test, establish, demonstrate and spread the arid zone viable best practices in water conservation, farming, composting, food processing and livestock. On an average, this campus gets a footfall of over 8,000-10,000 people yearly.

To be implemented in phases, the key components of the project are:

- Rain-water-harvesting to achieve 100% off the supplies water availability
- Wind-Solar hybrid power generation for lighting and irrigation
- Development of an all-organic farm and up-scaling it into a producers company
- Demonstration centre and innovation platform for agriculture and allied areas with particular focus on arid zone agriculture, like, setting up of seed bank and selling spot
- Capacity building platform and resource centre for farmers
- Exploring the replication of the model in the village common-lands

Within the larger intervention to promote the sustain principles of farming, promoting azolla for livestock is an important component. It has high relevance to the desert and the livestock culture of western Rajasthan.
**Why Azolla?**

Despite being the second largest milk producing state of India, in Rajasthan there acute shortage of feed and fodder for dairy animals. The rapid shrinkage of common lands of the villages and expansion of urban areas also led to disappearance of grazing lands and pastures. Traditional sources of cattle feed like oil cakes and coarse grains also declined as other cash crops occupied their areas. Such varied factors have contributed in an inter-linked way to aggravate the fodder crisis. A number of synthetic antibiotics, steroids and vitamins are used to increase the production of milk. These chemicals may accumulate in the human body, through the consumption of animal products could cause various degenerative diseases. If we can substitute the cattle feeds with natural feeds that are rich in useful nutrients, it will be of great importance for human and animal health. Azolla can be used as a good substitute for the cattle feed which holds the promise of providing a sustainable feed for livestock.

**What is Azolla?**

Azolla is a floating fern and belongs to the family of Azollaceae. Azolla hosts symbiotic blue green algae, *Anabaena azollae*, which is responsible for the fixation and assimilation of atmospheric nitrogen. Azolla, in turn, provides the carbon source and favourable environment for the growth and development of the algae. It is this unique symbiotic relationship that makes azolla, a wonderful plant with high protein content.

**What are Azolla’s benefits?**

Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12 and Beta-Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. On a dry weight basis, it contains 25 - 35 percent protein, 10 - 15 percent minerals and 7 - 10 percent of amino acids, bio-active substances and bio-polymers. The carbohydrate and fat content of azolla is very low. Its nutrient composition makes it a highly efficient and effective feed for livestock (see Table). Livestock easily digest it, owing to its high protein and low lignin content, and they quickly grow accustomed to it. Moreover it is easy and economic to grow. Milk yield increases by 15 to 20%.

<table>
<thead>
<tr>
<th></th>
<th>Annual biomass production</th>
<th>Dry matter content</th>
<th>Protein content</th>
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<tbody>
<tr>
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<td>250</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>Lucerne</td>
<td>80</td>
<td>16</td>
<td>3.2</td>
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<td>Cowpea</td>
<td>35</td>
<td>7</td>
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IV. The Study:

The purpose of the study was to conduct an impact assessment of promotion of Azolla during the phase 1 of Urmul Farm intervention in the year 2016-17. It is expected to reflected on the success or failure, and the learning of the intervention. This will help better draft the strategy for the coming phases of the farming and sustainability work in the region and elsewhere. The learning of this intervention could facilitate promotion Azolla as a sustainable, economical and high value source of feed for livestock in the desert regions.

Sample and Methodology

This was done through a survey and case studies. The survey was conducted in nine villages in Kolayat block of Bikaner district. The sample was direct purposeful sampling (since this was an intervention) and consisted of 40 respondents across four castes.

V. Survey Results:

Descriptive characteristics of survey sample:

Figure 1: Village Distribution
Figure 2: Caste Distribution

A majority of the respondents came from Gadiyala, Pethdasar and Bajju villages and belonged to Meghwal caste.

Figure 3: Education

Figure 4: Number of family members
Almost a quarter of the respondents were illiterate while another 30% were only literate. Only less than half the respondents had a formal education. Moreover, more than half the survey sample had between 5 and 6 family members while almost a fifth had between 7 and 10 family members. In the absence of non-farm opportunities this placed a lot of pressure on good farm practices to make agriculture sustainable and viable.

Figure 5: Do you own land?

Figure 6: Size of Land

As shown in Figures 5 and 6, 100% of the respondents owned land, of which 50% owned between 20 and 50 bighas, 20% owned between 0 and 10 bighas and 17% owned between 11 and 20 bighas. Thus, more than half the survey sample held large land holdings, making them an adequate sample for testing the impact of azolla.
**Introduction of and Preparation for growing azolla:**

Since this was an intervention that was introduced by Urmul, Urmul had held trainings on azolla to educate farmers on its uses, methods and benefits. Thus, the entire survey sample had first become aware of azolla through Urmul.

**Figure 7: How did you become aware about azolla?**

**Figure 8: How did you obtain azolla seeds?**
Since this was an intervention begun by Urmul, Urmul provided the seeds for the farmers initially. However, word spread to neighbouring villages and about 7% of the sample obtained it from their relatives in villages where Urmul had originally begun this initiative. Since this was an Urmul initiative and a pilot, the farmers did not have to pay for the seeds they received.

**Figure 10: What is the nature of your pit?**

- **Temporary**: 100%
- **Permanent**: 0%
- **No response**: 0%

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**Figure 9: Did you pay for the seeds you received?**

- **Yes**: 5%
- **No**: 95%
- **No response**: 0%
Since this was a pilot test on whether or not azolla works and is beneficial, all the respondents made a temporary pit. The cost of making the pit varied amongst the sample; it cost between Rs. 1000-1500 for 35% of respondents, it cost 30% of respondents nothing, and between Rs. 500-1000 for 20% of respondents. Cost variation occurred due to the remoteness of the farmer from the nearest sourcing point. In most cases it is Bajju village market. The average distance in this case would be 70 kilometers.
As can be seen from Figures 12 and 13, the process of growing azolla is quick; 90% of all respondents were able to make the pit within two days while the remaining 10% made it in 3 days. Moreover, once the pit is made, more than half the respondents said it took only between 10-20 days for azolla to grow, while it took 20-30 days for 35% of the respondents. Thus, introducing azolla as a farm practice in the first instance appears to be a relatively easy and quick process.
Not only is azolla easy and quick to grow the first time, but it is grown back within 24 hours for 90% of the respondents, which makes it very viable as livestock feed. In addition, while roughly 60% of the respondents said the quantity of azolla that grows every day is 1-2 kgs, 30% said this was 2-4 kgs. Both quantities however, are sizeable amounts towards constituting daily requirements of livestock feed.

**Comparison with other forms of livestock feed**

**Figure 16: Percentage of livestock feed satisfied with Azolla**
As seen from Figures 16 and 17, almost three quarters of the sample feeds livestock between 0-20 kgs food every day. Although a large proportion of the sample did not substitute this feed with azolla, except for about 17% of the respondents, this might have been since this was a pilot. Yet, over a quarter of the sample used azolla as an additional supplement to first understand its results. This is also evident from Figure 18, in which 95% of the respondents said they used other forms of livestock feed. A significant learning from this pilot came in the form of azolla not surviving or the pit not being successful due to excessive heating, as was faced by almost 60% of the sample. Since this was the first time, it brought out learning that while things might have to be done a bit differently the next time, using azolla is potentially beneficial, as seen from the remaining sample’s results.
Figure 19: Cost of other livestock feed per year (apart from azolla)

Figure 20: Cost of using azolla per day

As seen in Figures 19 and 20, the cost of using other forms of livestock feed are between Rs. 2500 to Rs. 10,000 per annum for about half the survey sample. In comparison, a little less than half the survey sample spent less than Rs. 5 on azolla per day, amounting to less than Rs. 1800 per annum as an upper limit. The remaining sample could not provide an estimate since the azolla did not survive. In any case, the cost of using azolla is much lower than that of using other forms of livestock feed, and can provide monetary benefit to the farmers.
**Impact Assessment of using azolla:**

**Figure 21: How much do you save on inputs by using azolla?**

As seen in Figure 21, since azolla is used primarily as an additional supplement at this stage, there is not much saving on input costs, with 95% of respondents not saving anything by using azolla. However, it is also worth noting that those who did substitute at least some proportion of traditional forms of livestock feed with azolla saw a significant saving, with at least 3% of respondent saving Rs. 3600 per annum.

**Figure 22: Is azolla healthier for cattle**

**Figure 23: Is there an increase in cattle produce since you started azolla feed?**

As seen from Figures 22 and 23, azolla has good health benefits for cattle. 62% of respondents saw an improvement in cattle’s health due to azolla, and at least 50% of the survey sample saw an increase in cattle produce since they began feeding the cattle with azolla. In fact, not a single respondent said that they did not see an increase. The other 50% who did not respond in the positive had either been unable to make the pit successfully or the azolla had not survived, due to which they were unable to respond to this question.
As seen in Figures 24a and b, of the respondents who said that they had seen an increase in cattle produce, 55% had not measured the increase, but 45% saw an increase of between 300 and 700gm per day. This increase in cattle produce would fetch farmers a lot more money in the market. Thus, of the farmers whose azolla did survive and who did see an increase in cattle produce, 55% said they would gain between Rs. 10 and 20 per day i.e. between Rs. 300 and Rs. 600 per month while another 10% said this would fetch them more than Rs. 20 per day on the market i.e. more than Rs. 600 per month. 35% of farmers who found increases would not gain monetarily from such increases since they were using the extra produce for household consumption. However, increased cattle produce meant increased quantity of milk for their families.
Although roughly 50% of the survey sample could not see benefits from azolla since their pits had been unsuccessful or because azolla had not survived due to high temperatures, the remaining 50% did see monetary benefits. Roughly a third of all respondents saw a monetary gain of upto Rs. 1500 per month while 3% gained more than Rs. 1500 per month. However, since this was the pilot, 20% of the respondents had not measured the gain. Significantly, 38% of the sample thought they would be more financially secure next year and attributed almost the entire effect of this to azolla. It is again important to note here that the 58% who said they would not be more financially secure next year consisted of respondents who were unable to grow azolla or whose azolla crops had not survived.
As seen in Figure 27, farmers who managed to grow azolla found several benefits from azolla. Almost half the respondents thought this was a good innovation for animal husbandry, and almost a fifth said it brought them increased revenue. Significantly, although half the respondents were unable to grow azolla or their azolla had not survived, almost the entire survey sample responded positively when asked if they would use azolla next year as well. This demonstrates that even though half the sample had been themselves unable to reap the benefits of azolla this year, they had seen such benefits to their neighbours and relatives, and had decided that it was worth trying it once again.
Interestingly, as shown in Figure 29, a small percentage of the sample survey was interested in expanding the use of azolla for other purposes, or example in alternative agricultural production and as a fertilizer. Although this was a small percentage, it demonstrated the interest already generated in that some farmers were already planning to take their use of azolla to the next level.

VI. Some experiences from the field

1) Parvati from village Pethdasar, block Kolayat, district Bikaner, owns 25 bighas of land, where she primarily grows rain fed Guar (Cluster Bean). Before using azolla, she spent Rs. 5000 on transport and Rs. 1350 on khal (Livestock fodder add-on or nutrient) per year. She did not have seed or grass expense since they used material from their farms. In September 2016, Parvati attended a training by Urmul on sustainable farming and obtained azolla seeds from Urmul. She made a temporary pit with area of 60sqft in two days that cost her Rs. 1100, and fed about 2 kgs of seeds worth Rs. 200 in the pit. After 18 days, the azolla began to grow and was replenished within 24 hours after plucking. Per day, around 1-2 kgs of azolla grows in the pit and she uses this for livestock feed. Although the feeding pattern had remained the same since a very short duration has passed, and azolla has not substituted any of the 6kgs of livestock...
feed fed to cattle every day, it is added in the dry fodder or khal. Although there have been no savings by using azolla for livestock feed yet, there has been an increase of 700ml of milk yield per day which will fetch Rs. 28 more on the market per day. This more than recovers the cost of Rs. 2 per day of using azolla for livestock feed. Thus the total monetary benefit for Parvati is Rs. 840 per month and Rs. 6720 per year owing to more milk and hence more money from animal husbandry. Parvati thinks because of this she will be financially more secure this year and plans on continuing the use of azolla for livestock feed, also in combination with other forms of feed, next year. The programme team at Urmul suggests that in the coming few months, the azolla consumption could easily be increased to about 50%. This would mean 50% reduction in the cost of khal procurement.

2) Raju Ram from village Pethdasar, block Kolayat, district Bikaner, owns 25 bighas of land in which he primarily grows rain fed guar. Before using azolla he spent Rs. 3800 on seeds, Rs. 4800 on transport and Rs. 2300 on khal i.e. total of Rs. 10,900. He obtained seeds from Urmul after attending a meeting and built a pit of area 60 sq.ft in two days which cost him around Rs. 1600. He put 2 kgs of seeds and after 18 days azolla began to grow. Around 1.5-2 kgs of azolla grows in the pit every day and is replenished within 24 hours. On average, he feeds livestock about 6kgs per day, and spends about Rs. 2300 per annum per animal on cattle feed. Comparatively, it costs only Rs. 4-5 a day to use azolla. After adding azolla to cattle feed, he has reduced cattled feed by 1 kg per day, which amounts to a 50% reduction in cattle feed. Thus, he has managed to save Rs. 690 per month on cattle feed. In addition, there has been an increase of 500 gm of milk per day which will fetch him an addition Rs. 15 a day or Rs. 450 a month in income. He thinks azolla is healthier for cattle since the overall health of the animal also seems to have improved. Moreover, if a 5 month milking cycle can be maintained at the same rate, he will get an additional income of Rs. 2250 per year owing to azolla, and he also expects milk yield and health of the animal to improve by next year. He plans to continue using azolla for livestock feed next year and hopes fellow farmers also adopt this technique.

VII. Conclusion and way forward

As seen from the survey results and case studies, overall there has been a positive response towards azolla; people have gained significantly monetarily, and they have also been able to increase their quantity and quality of milk consumption at home for their families. The use of azalea has permitted improved health of livestock and increased milk production which enables increased monetary benefits in the markets, and can also lead to significant decreases in cost of livestock feed. The biggest benefit is that a significant proportion said that owing to azolla, they would be more financially secure next year, which is a great step forward towards sustainable livelihoods and provides scope for expanded use of azolla in other fields. In fact, although a small proportion, but the survey demonstrates that interest in diversifying azolla use has
already begun and the farmers are taking a keen interest in potentiality and possibility of alternative agricultural production with azolla playing a significant role. Thus, azolla emerges as a viable and sustainable alternative that is both economically feasible and environmentally sound.

Yet, since approximately half the survey sample was unable to grow azolla either because they were unable to make the pit successfully or because azolla did not survive, it is necessary to provide increased training and pay careful attention to how this may be prevented. Further work is required in the coming year(s) to promote azolla farming rigourously. There is a tremendous scope for scaling up of azolla usage in the Thar desert, given the widespread livestock rearing culture – which is the primary livelihood in the region – more important that even the farming. It is still a very optimistic outcome however, that despite such a larger proportion not being able to grow azolla, 97% wanted to grow it next year. This demonstrates the interest and the evident benefit of azolla on animal husbandry. It also outlines the scope for expanding the use of azolla to other fields.

In addition to the livestock feed, azolla farming should also be promoted as a field nutrient. A product which is a great source of nitrogen and could be used in the farm for organic matter compounding and nitrogen content boosting.

The author advises the continuation of the impact assessment in the year two of the intervention. This will give a comparative analysis of the impact and the spread. it will also permit analysis of actual financial security owing to azolla. There will be a unique set of challenges coming visible in the coming months and the following phases of the intervention. This needs to be carefully documented for course correction and strategy development.
Some pictures from the field:

Community women learning about Azolla

Community member feeding Azolla to livestock
Temporary azolla pit set-up in a village