A Typology of Farmers' Drought Management

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Abstract: Drought is a slow-onset natural disaster that has widespread consequences. Planning at macro and meso levels often assumes that farmers react to and manage drought in similar ways. If this assumption of homogeneity is incorrect, the potential effectiveness of drought mitigation efforts is likely to be dangerously inhibited. This research investigated the validity of the homogeneity assumption among Iranian farmers. More specifically, it examined whether farmers use different strategies to mitigate drought and, if so, whether a typology to classify their management approaches can be developed. A multistage, stratified random sample (n=258) of farmers in Fars province who suffered drought was surveyed. The research identified that different strategies were used and that a drought management typology comprising three types of drought management could be constructed: (i) technical (TDM) (ii) psycho-economic (PDM) and (iii) integrated (IDM). These three drought management approaches were discussed and recommendations made to improving drought mitigation and preparedness.

Key words: Drought management % Typology % Impact % Farmers % Iran

INTRODUCTION

Drought is a normal, recurrent climate feature [1] which, if badly managed can lead to a loss of crop production, food shortages and, for many, starvation [2]. It originates from a deficiency of precipitation over an extended (although not indefinite) period, although its characteristics vary significantly from one region to another [3]. However, drought should not be viewed merely as a physical phenomenon; it has profound impacts on society, socio-economic factors contribute to the social experience of drought and social activities may lessen or exacerbate the physical aspects of drought [3,4]. Particularly over the last decade, unsustainable development and improper use of natural resources have increased vulnerability to drought in some countries, to the extent that even a small abnormality in climatic conditions has the potential to create disaster in drought-stricken regions [5].

Many consider drought to be the most complex but the least understood of all natural hazards, affecting more people than any other [6]. Yet, for all the damage it causes, it gets precious little public attention. Of all natural disasters, it is the most gradual and hard to predict. Confusion about its characteristics within the scientific and policy communities explains, to some extent, the lack of progress in drought preparedness in most parts of the world. The lack of a precise and universally accepted definition adds to the confusion: when does the lack of rain constitute a drought and how do we measure the degree of severity [7] Drought is difficult to define because its boundaries are unclear and so much depends on context and location [8]. Various scientific disciplines define drought differently with the critical variables being the intended use of the water and the time-frame [9]. The four main disciplinary definitions of drought are meteorological, agricultural, hydrological and socioeconomic [10]. The meteorological definition is based on a measurement of precipitation that is some percentage below normal [1,10]. As regions differ greatly in climate, this definition is very location specific. A hydrological drought is defined by the levels of surface and subsurface water in the system [10]. Agricultural drought refers to a time when the amount of water in the soil no longer meets the needs of a particular crop [1]. Socioeconomic drought refers to situations where the reduction precipitation has impact on the wellbeing of the affected community, in effect as a distortion in the supply and demand for goods and services. There is a flow-on ripple effect from

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the physical water shortage that can be traced through economic systems [11] and affects the general public through an imbalance in supply and demand [1,10].

The end point of a drought episode is difficult to determine. The extent of its impact is critically tied to underlying social and economic vulnerability, much more than for sudden hazards, such as earthquakes. These attributes contribute to the rich development of conceptual frameworks about drought, especially drought vulnerability.

The Potential Impacts of Drought: The impacts of drought are diverse although can be broadly classified as being economic, environmental and social. They can be direct as well as indirect (first order, second-order) [12]. In societies where agriculture is the primary economic activity, the direct, or first-order, impacts of drought take the form of decrease food production via a reduction in cultivated area and/or crop yield. Employment opportunities are reduced because of the diminished need for weeding, harvesting and other agricultural work and because farmers seek to save money by reducing their expenditure and farm inputs. Concurrent with reducing the production, grain and other food prices usually rise rapidly during and after a drought [13,14]. Decreased food production, abnormal increases in prices and the lack of availability of jobs all act to reducing the access to food of rural people, especially small farmers and landless labourers [2].

In agrarian countries, crop adjustments usually constitute the focal point of risk aversion strategies adopted by victims of natural hazards at the household level [15,16]. However, if people believe they can do nothing to reducing crop losses, they will take no action [17]. Paul [2] concluded that drought victims in Bangladesh were often obliged to borrow money and food and/or sell their land and other belongings. At the community level, friends, neighbors, relatives and more affluent members of the local community may aid drought victims by providing food, cash and loans.

People's actions often exacerbate the impact of drought. The resultant economic and environmental impact and personal hardship experienced following recent droughts in both developing and developed countries have underscored the vulnerability of all societies to this "natural" hazard [3]. Disaster researchers have frequently argued that poor people are more vulnerable to the consequences of natural hazards than those with greater economic resources [18].

Drought Management: The impacts of drought, like those of other hazards, can be reduced through mitigation and preparedness [7]. Drought management is carried out at the macro, meso and micro levels. At the macro level, national governments plan and execute programs, laws and regulations to mitigate drought, often seeking international support. They are responsible for minimizing the hardship by organizing relief work, providing loans and generating employment schemes for victims [19]. At the meso level, local governments try to mitigate drought with regard to national opportunities and local challenges. Farmers are in the forefront of drought management and suffer most from the consequences. Therefore, the micro-level management that is what farmers do with regard to drought is of great importance. Viljoen *et al*., [20] found that social, institutional, cultural, religious, economic, environmental, hydrologic, geographic, educational and political factors are all important in developing effective drought management policies and strategies.

Watts [21] argued that vulnerability and response to drought are likely to reflect qualities inherent in social systems. External responses to potential crises must acknowledge the important but culturally variable role of these intrinsic factors in mediating the implementation and effectiveness of local coping strategies [22].

In the past, drought management has been blurred and often politicized due to confusion in defining and analyzing the causes and effects of drought. Efforts to mitigate droughts require a clear understanding of when they occur and the distinction between manageable droughts, where improved land management can assist in mitigation and unmanageable drought, when coping mechanisms outside the managed landscape are required [23].

White [24] identified three types of human adjustment or response to the risks of natural hazards, aside from simply accepting the loss. One response is to spread the burden more widely with public disaster relief programs or disaster insurance for example, programs insuring farmers against crop yield losses in case of drought. The second type of adjustment is to modify the hazard event. In the case of drought, constructing water storage and conveyance structures is the standard modification to reduce drought impacts. The third type of response is to reduce human vulnerability. In the case of drought, policies to reduce vulnerability include changes in rules and laws governing water management [25].

Drought management at the macro and meso levels remains a challenge and has been criticized for its ineffectiveness. Several obstacles have been identified, including lack of full understanding, low priority, inadequate financial or human resources, bad communication between levels of government, precedence of inefficient short-term relief programs over long-term resource management and inadequate science [26,27,8].

Regardless of the quality of drought management at the macro and meso levels, mitigation cannot be realized unless effective micro level management is carried out by drought victims. They utilize various strategies to reduce the first-order effects of the hazard; for example, by resowing crops to offset the reduction crop area and irrigating to increasing yield. Without such adjustments, they will experience lower-than-normal food production, which may threaten their food security. They are often compelled to borrow money or sell their land, household goods and/or livestock, often at depressed prices, in order to buy food. At this time, they may start to consume wild food that they would not otherwise normally eat, thus exacerbating the impact of the drought on biodiversity. These practices provide an early warning of impending famine and indicate the need for the national government and NGOs to mobilize the supply of additional food to distribute to the affected people. Thus, an integrative framework is essential to link the responses taken at various levels to mitigate the effects of drought effectively [2].

It is evident that farmers are proactively doing something for their survival in times of disasters such as drought. The array of initiatives shows that community livelihoods depend on a number of activities, capabilities and assets both material and social. McKenzie [28] found that households adjusted to a crisis by reducing expenditure on durable and nonessential items in order to purchase basic food items. The postponement of having children is another strategy. One way to counteract falling wages is to increase the number of hours worked. Finally, another survival strategy is for households to reduce outgoings (such as expenditure and loan repayments) and to increase incoming transfers, such as financial support from abroad. In effect, international risk-sharing has substituted for the inability of domestic risk-sharing [29].

Typologies of Farmers: Although the presumption of homogeneity is prevalent in the policy community, rural sociologists have long advocated for an awareness of the diversity or heterogeneity of farmers. Vanclay [30] argued that one way of theorizing the diversity amongst farmers is the Styles of Farming approach originally developed by van der Ploeg. Although there is disagreement regarding how farming styles research could be used to improve extension, there is a general belief that such research would be useful for extension [31-34].

Both qualitative and quantitative methods have been used to identify the potential farming styles that exist in a farming community. Howden and Vanclay [35] conducted focus groups to identify the farming styles amongst Australian farmers. However, after considerable immersion in the field, they concluded that the focus group methodology was potentially misleading and therefore resorted to constructing a researcher- defined (or etic) typology [33]. Fairweather and Klonsky [32] argued that Q methodology is an appropriate method for identifying farming styles. Hayati and Karami [36] used survey research with open-ended questions and then undertook a content analysis to identify the typology of causes of poverty among Iranian farmers. Karami [37] conducted a cluster analysis to classify farmers into homogenous groups in order to study the appropriateness of their decision regarding selection of irrigation methods.

Farmers are clearly at the forefront of drought management, suffer most from the consequences of drought and have the greatest influence on its mitigation. Developing a typology of farmer drought management strategies would be a useful heuristic for understanding drought mitigation and in thinking about improving drought management at different levels. However, one of the conscious or unconscious assumptions among field workers and local and national mitigation experts is that drought has the same impact on all farmers and their reactions to drought are similar. The aim of this study was to investigate the validity of this assumption among Iranian farmers. More specifically, it examines whether farmers use different strategies to mitigate drought and, if so, whether a typology to classify their management approaches can be developed.

Method: A pre pilot study, field observation and in-depth interviews with farmers were used to develop the questionnaire that collected data for this study. The face validity of the questionnaire was approved by a panel of experts. It was field-tested in a pilot study that included 30 farmers from eight villages, which were not the villages that were ultimately selected for the study. Cronbach alpha reliability coefficient for social impact, attitude toward control, impact on agriculture, impact on

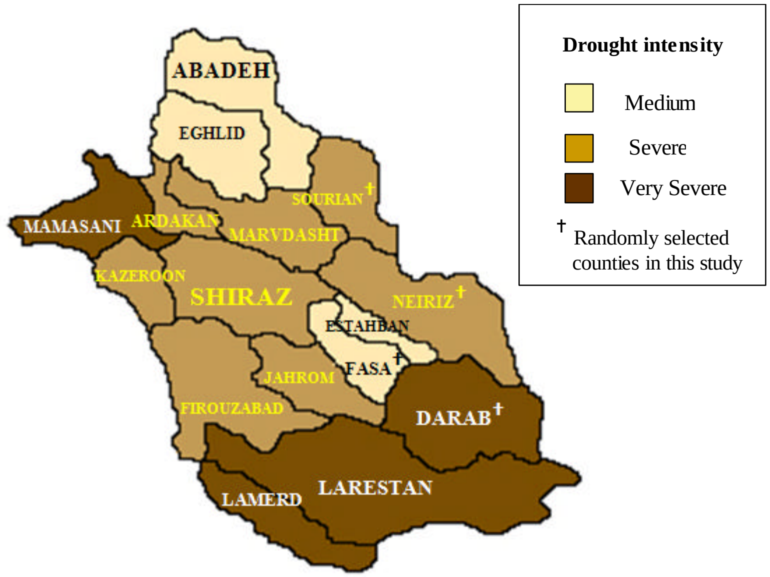

Fig. 1: Classification of drought intensities across Fars province [38]

household economy, impact on environment and support services scales were 0.69, 0.53, 0.92, 0.63, 0.62 and 0.88, respectively. The questionnaire was revised based on the pilot study and used in the survey to collect data for this research.

Study Area: This study was conducted in Fars province, one of the 30 provinces of Iran. Located in the south of Iran, Fars province has an area of 122,400 km^2, with its regional capital city being Shiraz. The population of the province is over 3 million, of whom about 42 percent reside in rural areas. The Zagros Mountains stretch from the northwest to the southeast, dividing the province into distinct geographical regions. Since the latest division, the province now contains 17 counties (*Shahrestan*). There are three distinct climatic regions 1) the mountainous area of the north and northwest which have moderately cold winters and mild summers 2) the central region, with relatively rainy, mild winters and hot dry summers and 3) the south and southeast region, which has moderate winters and very hot summers.

Fars is one of the drought-prone areas of Iran and experienced a severe drought between 1998 and 2003. In 2004, when the data for this study were collected, farmers were still suffering from the ongoing consequences of that drought. Sufi's [38] drought classification of Fars counties was used in the sampling design of this study (Fig. 1). Sufi [38] used a meteorological definition in his drought classification. Counties with less then 20, 20-30, 30-45, 45-60 and over 60 percent reduction in precipitation were classified as experiencing nil, mild, moderate, severe and disastrous drought conditions, respectively.

Population and Sample: Farmers of Fars province who suffered drought were the target population. A multistage, stratified random sampling method was used. At the first stage, the 17 counties were classified into three strata using Sufi's [38] scheme. A proportional sample was then randomly selected from each of the three drought strata. In each randomly select county, a proportional number of *Dehestan* (subcounties) was randomly selected. A proportional sample of *Deh (s)* (villages) was then randomly selected from each *Dehestan*. In the final stage, a random sample of farmers was selected in each *Deh*. The number of farmers selected in each *Deh* depended on the number of household in that village. In all, four counties and 32 villages were included in the sample. The final sample consisted of 258 farmers, including 78, 118 and 62 farmers from counties with "disastrous", "severe" and "moderate" drought, respectively.

Variables and Measurements

A Description of the Important Variables Used in this Research Is Presented Below:

Farm Size (Hectares): Total hectares of agricultural land managed by a farmer *Income* (Toman): total annual income of a farm household from agricultural and nonagricultural sources.

Loss of Income (Percent): Farmers' perception of percentage loss in income due to drought.

Social Impact (Scale): The impact of the drought on the household's social life, including psychological stresses, health threats, social participation, conflict among villagers and food consumption. The scale ranged from 8 to 40, with a high score indicating severe impact.

Attitude Toward Control (Scale): Farmers' attitudes about their ability to control drought and its consequences, including such dimensions as effectiveness of coping attempts, acceptance as destiny (i.e. fatalism, nothing can be done about it) and existence of effective ways to control drought. The scale ranged from 7 to 35, with a high score indicating confidence that drought can be controlled.

Impact on Agriculture (Scale): Farmers' attitudes covering such dimensions as impact on yield, soil fertility, erosion, pests and diseases, orchard production, production costs and animal production. The scale ranged from 0 to 100, with high scores indicating severe impact.

Impact on Household Economy (Scale): Farmers' perceptions of the drought's effect on the price of land, selling assets, unemployment and the price and receipt of supports, such as permission to dig wells. The scale ranged from 0 to 100, with high scores indicating severe impact.

Impact on Environment (Scale): Respondents' attitudes toward the impact of drought on wild plants and animals, air pollution and water quality. The scale ranged from 0 to 100, with high scores indicating severe impact.

Support Services (Scale): Measured whether drought-affected farmers received government aid, drought-related loans, support to construct check dams or canals or to dig wells, crop insurance and support from family and friends. The scale consisted of 6 items and ranged between 0 and 1.

RESULTS AND DISCUSSION

Macro- and meso-level planning often assumes that farmers' reaction to and management of, drought is homogenous. If this assumption is false, the effectiveness of drought mitigation efforts is likely to be impaired. This research investigated the similarity/dissimilarity of drought management efforts among Iranian farmers using cluster analysis. Primary data analysis indicated that k-means cluster analysis, in which the number of clusters is determined in advance, was the most appropriate approach for this study. The independent variables used in cluster analysis were consequences of drought (agricultural, general economic, environmental and hydrologic); application of adaptive strategies (technical and psycho-economic) attitudes toward drought (social impact and controllability) use of support services (access to and degree of participation in, extension drought programs); and fluctuation in income and cultivation area (owned, rented land, etc.).

The cluster analysis revealed the following drought- management typology based on farmers' adaptive strategies:

Technical Drought Management (TDM): About 17 percent of farmers used this management approach, which is marked by predominantly technical strategies.

Psycho-economic Drought Management (PDM): Relatively limited agricultural resources forced these farmers to look for other management approaches; 18 percent predominantly applied psycho-economic adaptive strategies in their struggle to manage drought.

Integrated Drought Management (IDM): 65 percent of farmers combined technical and psycho-economic strategies to manage drought.

Adaptive drought-management strategies studied in this research were identified by conducting indepth interviews with farmers, field observation and literature review. In all, 32 adaptive strategies were identified and classified by experts as being either technical or psycho-economic (Table 1). The drought management approach applied by a farmer is a function of his knowledge, resources and a host of other factors. The key application of the above finding is that farmers' management of drought is not homogenous and that any mitigation plan that ignores this typology is likely to fail. A more detailed description of the typology is presented in the next sections.

Analysis of Technical Drought Management (TDM Table 1): For the group of farmers who applied TDM, psycho-economic adaptive strategies are of limited use. Even if they resort to them, they consider them to

Table 1: Adaptive strategies used by farmers in the Technical Drought Management (TDM) group

Adaptive strategies	Farmers using the practice (%)	Priority of use (rank)	Effectiveness (%)	Priority of effectiveness (rank)
Deepening irrigation well	96.8	1	58.3	20.5
Praying†	86.0	2	29.7	28
Reducing cultivation	81.0	3	50.5	23
Weeding	77.5	4	66.1	18
Decreasing length of furrows	71.4	5	71.1	12
Selling livestock †	57.9	6	50.0	25
Reducing run-off	56.1	7	70.3	13
Digging deeper well	53.8	8	77.4	10
Using drought-resistant varieties	50.0	9	85.7	5
Leveling land	48.7	10	73.7	11
Practicing deficit irrigation	42.5	11	67.6	14
Practicing watershed	28.6	12	16.7	29.5
Purchasing extra water	26.1	13	80.6	8
Managing irrigation time	25.0	14	91.7	3
Improving water conveyance system	23.3	15	85.0	6
Avoiding second crop	21.6	16	60.4	19
Digging shallow well	20.0	17	50.0	25
Migrating (of household members)†	14.0	18	33.3	27
Constructing water reservoir	12.8	19	93.3	1
Lining Canals	11.9	20	80.0	9
Constructing new Canals	9.3	21	91.7	3
Changing crop pattern (drought-resistant)	7.1	22	55.6	22
Using a portable water supply	6.1	23	66.7	16
Finding a second job †	5.0	24	50.0	25
Producing a windbreak	4.9	25	66.7	16
Using mulch	4.8	26	83.3	7
Changing irrigation system	4.7	27.5	91.7	3
Selling lands †	4.7	27.5	58.3	20.5
Using conservation tillage	2.4	29.5	66.7	16
Minimizing tillage	2.4	29.5	16.7	29.5
Mixing crops	0.0	32	0.0	32
Reusing waste water	0.0	32	0.0	32
Renting land†	0.0	32	0.0	32

†Psycho-economic adoptive strategies

be ineffective. Among the 15 adaptive strategies most frequently used by this group, only two were psycho-economic (praying and selling livestock) and they were viewed as having limited impact (effectiveness rank was 23 and 25, respectively) on drought mitigation. This group has relatively more technical knowledge and resources. Analysis of its communication behavior indicted that it rarely uses agricultural extension services and depends on personal experiences and other farmers for information and advice.

The adaptive strategies with the highest priority included deepening irrigation wells, praying, reducing cultivation, weeding and decreasing length of furrows. Adaptive strategies with a use priority ranging from 6 to 15 included selling livestock, reducing runoff, digging deeper wells, using drought-resistant varieties, leveling land, practicing deficit irrigation and watershed, purchasing extra water, managing irrigation time and improving the water conveyance system. This group did not mix crops, reuse waste water, or rent land as drought-mitigation strategies and less than 5 percent tried finding a second job, creating windbreaks, using mulch, changing the irrigation system, selling land and using conservation tillage.

Farmers were asked to appraise the effectiveness of adaptive drought mitigation strategies. The Spearman correlation coefficient between priority of use and priority of effectiveness of drought mitigation strategies was not statistically significant (r=0.18, Sig.=0.32). This finding is interesting because it indicates that farmers in this group were not using the adaptive strategies they perceived as most effective to cope with drought. Constructing a reservoir, managing irrigation time, constructing new canals, changing the irrigation system and using drought-resistant varieties were ranked 1 to 5 in effectiveness, while the priority of use of these

Table 2: Adaptive strategies used by farmers in the Psycho-economic Drought Management (PDM) group

Adaptive strategies	Farmers using the practice (%)	Priority of use (rank)	Effectiveness (%)	Priority of effectiveness (rank)
Praying†	95.7	1	43.9	9
Selling livestock †	84.8	2	41.7	10.5
Finding a second job †	64.4	3	79.9	3
Migrating (household members)†	55.6	4	77.3	4
Reducing cultivation	39.1	5	19.4	19
Practicing deficit irrigation	30.4	6	34.5	13
Deepening irrigation well	19.6	7.7	33.3	14.5
Avoiding second crop	19.6	7.5	20.4	18
Decreasing length of furrows	17.4	9	41.7	10.5
Weeding	13.1	10	36.1	12
Selling lands †	11.1	11	26.7	16
Digging shallow well	10.9	12.5	23.3	17
Reducing run-off	10.9	12.5	50.0	7.5
Purchasing extra water	6.5	14	66.7	5.5
Improving water conveyance system	4.4	15	91.7	1
Using a portable water supply	2.2	18.5	50.0	7.5
Changing irrigation system	2.2	18.5	16.7	20
Lining canals	2.2	18.5	33.3	14.5
Constructing water reservoir	2.2	18.5	83.3	2
Using mulch	2.2	18.5	66.7	5.5
Changing crop pattern (drought-resistant)	0.0	27	0.0	27
Mixing crops	0.0	27	0.0	27
Using conservation tillage	0.0	27	0.0	27
Minimizing tillage	0.0	27	0.0	27
Using drought-resistant varieties	0.0	27	0.0	27
Leveling land	0.0	27	0.0	27
Managing irrigation time	0.0	27	0.0	27
Constructing new canals	0.0	27	0.0	27
Practicing watershed	0.0	27	0.0	27
Digging deeper well	0.0	27	0.0	27
Reusing waste water	0.0	27	0.0	27
Producing a windbreak	0.0	27	0.0	27
Renting land†	0.0	27	0.0	27

† Psycho-economic adoptive strategies

practices was 19, 14, 21, 27.5 and 9, respectively. Note that the priority of effectiveness for the five most frequently use practices were between 12 and 28. The fact that farmers use practices that they know are not effective while using practices that they appraise as effective less frequently requires further attention.

Drought mitigation in Iran is based on crisis management. During the crisis, the resources of both farmers and government shrink. Therefore, some of the practices the farmers appraised as effective (e.g., constructing a reservoir, changing the irrigation system, improving the water conveyance system) require relatively high investment, which is impossible in times of crisis. Crisis management is not also conducive to adopting practices that require long-term planning (e.g., drought-resistant varieties). The reason for frequent use of ineffective strategies (deepening irrigation wells, praying, reducing cultivation, etc.) is that they respond in the short-term and do not require a large investment. Praying ranks second in priority of use, while its effectiveness is ranked 28. Farmers attribute the ineffectiveness of prayer to their lack of faith.

Analysis of Psycho-economic Drought Management (PDM Table 2): Among the PDM group, the four most frequently used strategies were praying, selling livestock, finding a second job and migrating. The adaptive strategies with a use priority ranging from 5 to 10 were technical, including reducing cultivation, practicing deficit irrigation, deepening the irrigation well, avoiding a second planting, decreasing the length of furrows and weeding and they were used much less frequently than the psycho-economic strategies. Thirteen of the drought practices were not applied by any farmers in this group.

Table 3: Adaptive strategies used by farmers in the Integrated Drought Management (IDM) group

Adaptive strategies	Farmers using the practice (%)	Priority of use (rank)	Effectiveness (%)	Priority of effectiveness (rank)
Praying†	95.2	1	67.3	23.5
Reducing cultivation	88.9	2	64.9	29
Decreasing length of furrows	81.7	3	78.2	16
Deepening irrigation well	79.1	4	65.1	28
Selling livestock †	77.6	5	64.7	30
Weeding	72.4	6	79.0	13.5
Finding a second job †	66.2	7	77.9	17
Migrating (household members)†	58.9	8	75.6	18
Practicing deficit irrigation	55.1	9	66.3	27
Using drought-resistant varieties	51.3	10	88.5	2
Reducing run-off	44.1	11	80.3	10
Avoiding second crop	37.5	12	67.3	23.5
Digging shallow well	36.2	13	72.7	20
Leveling land	35.6	14	79.9	11
Improving water conveyance system	30.9	15	88.6	1
Purchasing extra water	28.5	16	79.0	13.5
Constructing water reservoir	23.5	17	86.4	7.5
Practicing watershed	20.0	18	25.0	33
Digging deeper well	16.5	19	81.4	9
Selling land †	11.9	20	68.4	21
Managing irrigation time	10.9	21.5	88.1	3
Changing crop pattern (drought-resistant)	10.9	21.5	73.5	19
Constructing new Canals	9.7	23	87.5	5
Lining canals	7.9	24	87.2	6
Using mulch	6.9	25	86.4	7.5
Changing irrigation system	6.7	26	87.9	4
Producing a windbreak	6.4	27	68.3	22
Renting land†	5.0	28	78.6	15
Using a portable water supply	4.6	29	66.7	25.5
Minimizing tillage	4.5	30	61.9	31
Reusing waste water	2.9	31	66.7	25.5
Mixing crops	2.6	32	41.7	32
Using conservation tillage	2.5	33	79.2	12

† Psycho-economic adoptive strategies

Another striking difference between the PDM and the other two groups was a strong significant correlation (r=0.75, Sig.=0.0001) between priority of use and effectiveness of practices. These farmers are using practices that they believe are effective. For example, the use rank for praying, selling livestock, finding a second job and migrating was 1 to 4 and their effectiveness rank was 9, 10.5, 3 and 4, respectively. However, two of the practices appraised as most effective - improving the water conveyance system and constructing a water reservoir (ranked 1 and 2) - were seldom used.

Analysis of Integrated Drought Management (IDM Table 3): About 65 percent of farmers used a balance of technical and psycho-economic strategies to mitigate drought, making it the most popular approach. Among the 10 adaptive strategies most used by this group, 40 percent are psycho-economic and 60 percent technical. The use of praying, selling livestock, finding second job and migrating ranked 1, 5, 7 and 8, respectively, while the use of technical adaptive strategies, including reducing cultivation, decreasing length of furrows, deepening the irrigation well, weeding, practicing deficit irrigation and using drought-resistant varieties, was ranked 2, 3, 4, 6, 9 and 10, respectively. The IDM group applied more adaptive strategies than the PDM group. The non significant correlation (r=-0.09 Sig.=0.61) between priority of use and priority of effectiveness indicated that the IDM group did not use the practices they viewed as most efficient. In this regard, their behavior is similar to the TDM group and different from the PDM group. These farmers ranked the effectiveness of improving the water conveyance system, using drought-resistant varieties, managing irrigation time, changing the irrigation system and constructing new

Table 4: Comparison of farmers' characteristics with regard to their drought- management typology

	Drought Management Typology				
Variables	IDM	TDM	PDM	F	P
Age (year)	$49.7^{a\,\dagger}$	53.9^{b}	53.8^{b}	4.83	0.01
Family size	6.9^{a}	6.4^{a}	6.6^{a}	0.49	0.61
Education (year)	3.7^{b}	4.3^{b}	2.0^{a}	4.63	0.01
Farm size (hectare)	8.8^{b}	14.7^{a}	9.1^{b}	3.42	0.03
Loss of income (percent)	57.3^{b}	39.3^{a}	61.0^{b}	11.5	0.001
Social impact (scale) ††	30.8^{b}	26.3^{a}	32.0^{b}	15.66	0.001
Attitude toward control (scale)	25.5^{a}	22.7^{b}	21.1^{b}	8.41	0.001
Impact on agriculture (scale)	74.9^{a}	72.1^{ab}	70.7^{b}	4.25	0.01
Impact on household economy (scale)	67.6^{a}	66.1^{a}	69.8^{a}	1.91	0.15
Impact on environment (scale)	73.5^{b}	66.0^{a}	77.8^{c}	10.30	0.01
Support services (scale)	0.9^{a}	0.7^{a}	0.7^{a}	1.85	0.16

†In each row, means followed by the same letters do not differ significantly (LSD P>0.05)

†† For description of variables and their measurement, see section 2.3

canals as 1 to 5, while their use was ranked 15, 10, 21.5, 26 and 23, respectively. The effectiveness of five frequently used practices-praying, cultivating less land, reducing the length of furrows, deepening the irrigation well and selling livestock - were ranked 23.5, 29, 16, 28 and 30, respectively.

Comparison of Drought-management Typology Groups (Table 4): The first question raised was whether the type of drought management preferred was related to drought severity. The findings did not associate typology with severity the three types were distributed relatively similarly among levels of drought severity (Chi-square=8.78 Sig.=0.067).

The second category of questions addressed the differences between farmers who pursued different drought management approaches. Farmers in the IDM group were significantly younger than those with TDM and PDM approaches. The mean ages of IDM, TDM and PDM farmers were 49.7, 53.9 and 53.8, respectively. The findings also indicated no significant difference in family size across drought management types, which runs counter to a popular assumption. The PDM group (*O* =2.0 years) had significantly fewer years of education than the IDM (*O* =3.7 years) and TDM (*O* =4.3 years). The farm size of TDM group (*O* =14.7 ha) was significantly larger than IDM (*O* =8.8 ha) and PDM (*O* =9.1 ha) groups, which explains this group's primary reliance on technical strategies. Access to more land enables them to solve their problems with limited use of external resources even during drought, while the other two groups depend to a greater extent on psycho-economic adoptive strategies.

The TDM group reported a significantly lower level of income loss due to drought (39.3 percent) than the IDM (57.3 percent) and PDM (61.0 percent) groups. This finding can be interpreted in two ways. First, it may indicate that TDM approaches are more effective in preventing income loss. Second, the IDM and PDM groups may pursue psycho-economic strategies because of their greater loss of income. A scale was used to measure the social impact of drought on farm households, including such variables as psychological factors, health, basic needs, social participation and social relations. The scale varied between 8 and 40, with 40 indicating a disastrous impact. The results indicated that drought had a significantly lower social impact on the TDM (*O* =26.3) group than the IDM (*O* =30.8) and PDM (*O* =32.0) groups. This finding is consistent with the findings on income loss and land ownership. The IDM and PDM groups, who have less land and lose more income, are expected to appraise the impact of drought as more severe. Farmers' attitudes about the possibility of controlling drought are hypothesized to predict their decisions about coping and the types of drought management approach they adopt. The scale developed to measure controllability ranged between 7 and 35, with a high score indicating confidence in achieving control. The IDM (*O* =25.5) group had significantly stronger confidence that drought could be controlled than the TDM (*O* =22.7) and PDM (*O* =21.1) groups.

Drought had a significantly greater impact on farmers in the IDM (*O* =74.9) than the PDM (*O* =70.7) group. The TDM group did not differ significantly from the other two in terms of the impact on agricultural production.

All groups perceived the impact on the household economy as high but differed significantly in their perceptions of environmental impact. The PDM (O =77.8) group perceived drought to have the most severe impact on the environment followed by the IDM (O =73.5). The TDM group (O =66.0) felt that drought's impact on the environment was less negative.

Farmers in all three groups seldom used support services, such as government aid and low-interest loans and noted that their access to drought- related agricultural extension programs was very limited. Only 13 percent of farmers in the IDM group indicated that they had access to agricultural extension programs, while this indicator dropped to 0.02 percent for the TDM and PDM groups.

CONCLUSIONS AND RECOMMENDATIONS

Barriers to effective drought preparedness and mitigation are manifold. A failure to link local-level capacities to national-level planning and implementation continues to characterize most instances of drought management. Outsiders' (macro and meso levels) imperfect understanding of local-level (micro) responses influences what happens before, during and after droughts and, hence, the policy prescriptions they advocate. This study found that the assumptions that drought has the same impact on all farmers and that their reactions are similar, were false. On the contrary, farmers use different management approaches to mitigate drought, which can be classified according to following typology:

- *Technical Drought Management* (TDM).
- *Psycho-economic Drought Management* (PDM) and
- *Integrated Drought Management* (IDM).

If the human dimensions of the typology found by this study are ignored, the presumed solutions of science, technology and engineering are doomed to failure. Recommendations for effective drought mitigation with regard to the management typology developed by this study follow.

The TDM group predominantly depends on technical strategies to cope with drought. Therefore, recommendations include:

- Provide more effective drought-related agricultural research and extension programs to promote more effective technical solutions for farmers in this group.
- Provide technical and economic support services to empower farmers to cope with drought, especially drought-related credit and loans and water conservation projects.
- Provide the necessary inputs to help farmers reduce the consequences of drought and be better prepared for future drought
- Consider that agricultural production is the primary source of survival for farmers in this group during drought.

The PDM group depends predominantly on psycho-economic adaptive strategies to mitigate drought. For more effective drought management macro- and meso-scale drought planning should provide:

- Training in nonagricultural jobs; farmers in this group depend on second jobs and migration to cope with the consequences of drought and a lack of training limits their opportunities.
- New job opportunities in drought-prone areas.
- Special drought research and extension programs that satisfy the needs of those members of farm households who stay on the farm
- Water conservation practices and support services that are appropriate to farmers in this group.

With regard to IDM group, promoting strategies that they perceive to be effective is recommended: improving water conveyance systems, making drought-resistant varieties available, managing irrigation time, changing irrigation systems and constructing new canals. The challenge is to ensure that research and extension provide the necessary knowledge and training to enable farmers to follow sustainable drought management practices within an IDM approach.

Government support services are not effective. Promoting more effective services that consider this drought-management typology is recommended. Most strategies that farmers in different management typology groups perceive as effective require resources and time, which are not available during a drought. Therefore, drought-prone areas should develop policies and preparedness plans that emphasize risk management rather than traditional crisis management approaches that emphasize reactive, emergency response measures [39,40]. Crisis management decreases self-reliance and increases dependence on government and donors. The overriding principle of drought policy should be an emphasis on risk management through the application of preparedness and mitigation measures. Awareness of the typology will increase field extension workers' and policy makers' ability to mitigate drought, therefore, further work on the methodology of drought management typology is needed in order to provide more robust classification.

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