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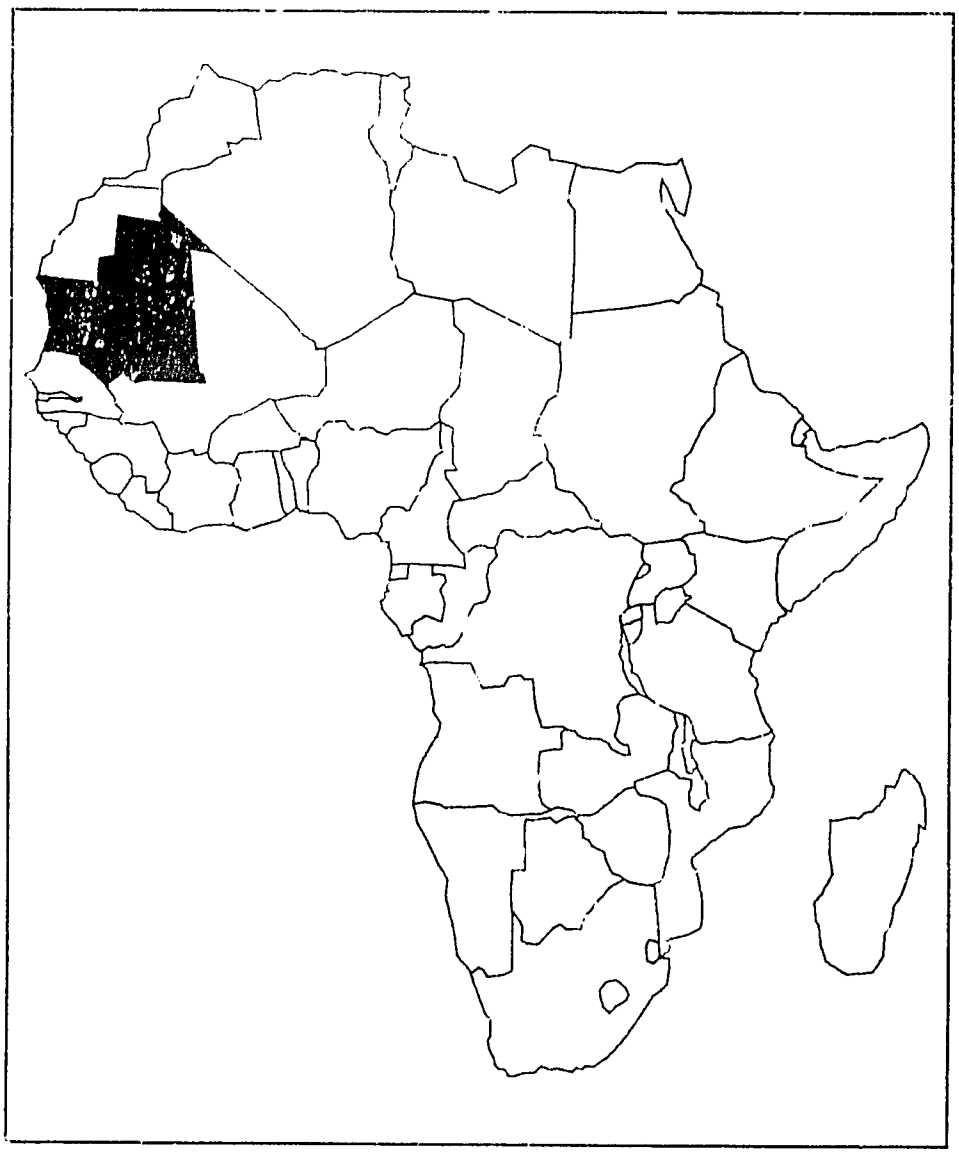
FEWS Country Report

DECEMBER 1988

MAURITANIA

Record Harvest Threatened

FAMINE EARLY WARNING SYSTEM



Produced by the Office of Technical Resources - Africa Bureau - USAID

FAMINE EARLY WARNING SYSTEM

The Famine Early Warning System (FEWS) is an Agency-wide effort coordinated by the Africa Bureau of the U.S. Agency for International Development (AID). Its mission is to assemble, analyze and report on the complex conditions which may lead to famine in any one of the following drought-prone countries in Africa:

- **Burkina**
- **Chad**
- **Ethiopia**
- **Mali**
- **Mauritania**
- **Niger**
- **Sudan**

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- preparing **Special Reports, maps, briefings, analyses, etc.** upon request; and
- responding to **special inquiries.**

Please note that this is the last monthly Country Report that will be published in this format. A new reporting schedule and format are being prepared.

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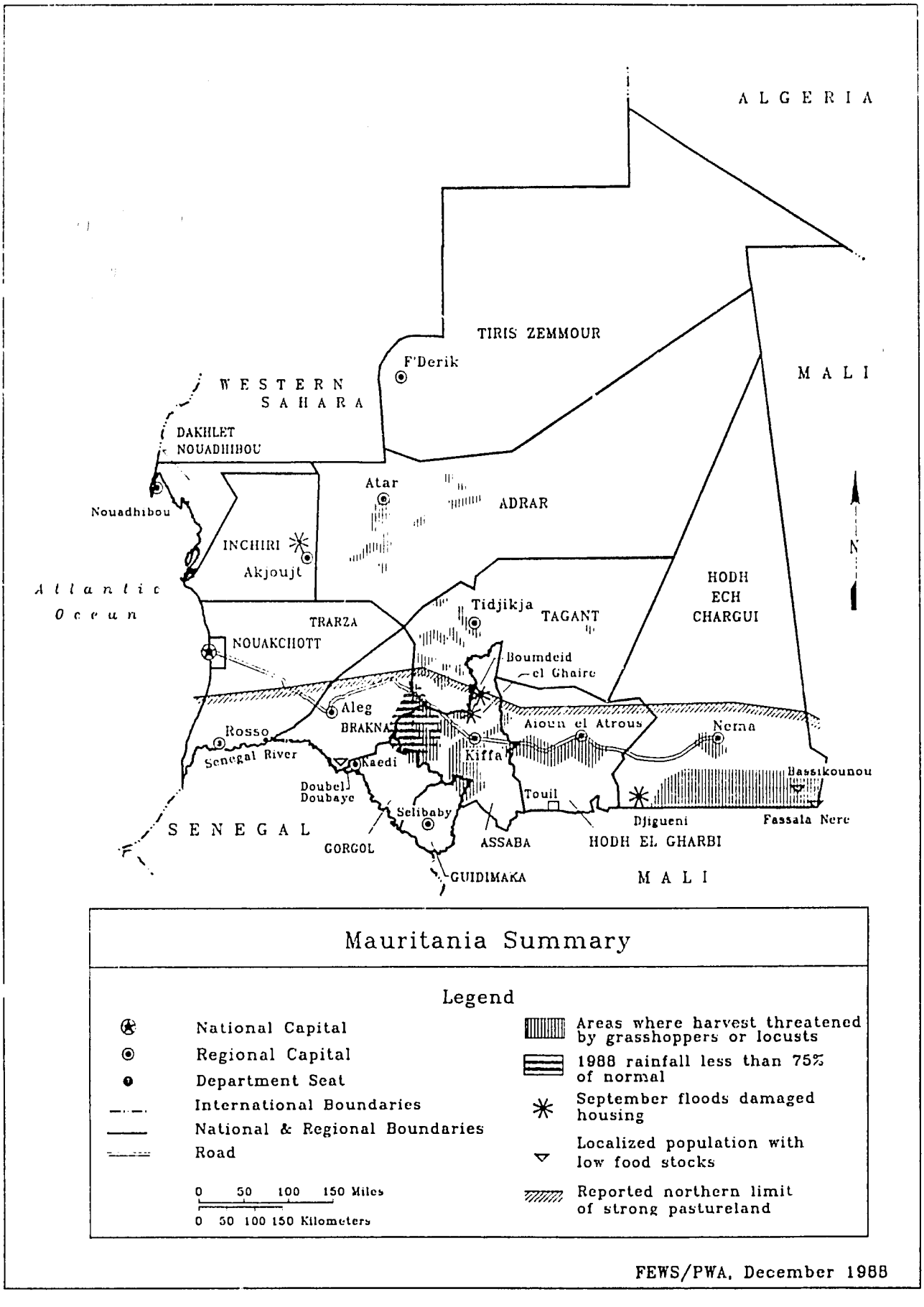
Map 1 - Summary Map



MAURITANIA

Record Harvest Threatened

Summary

Mauritania's record breaking 1988 harvest may contribute as much as 50% of the country's 1989 cereal needs, although intense locust and grasshopper damage seen in limited survey areas may be widespread enough to threaten it. Current carryover stocks plus expected imports, aid, and production will meet Mauritania consumption needs in 1989 even with a 30% crop loss to pests. Any loss above 10% of the harvest, however, would diminish private and public reserve stocks, damaging Mauritania's safety net for 1990. The UN Food and Agriculture Organization (FAO) and the Permanent Interstate Committee to Control Drought in the Sahel (CILSS) have been asked to re-assess the crop situation so that the full extent of pest damage can be determined. So far, the hardest hit areas appear to be the oases and southern Hodh ech Chargui Region.

A truckers' strike at the beginning of the 1988 lean season delayed food aid distributions by about two months, causing free distributions and food-for-work programs to fall short of their original targets by 45 and 30%, respectively. While the data are insufficient to tell whether vulnerable populations were served, the greatest share of free aid was distributed in Trarza and Brakna regions, both of which contained vulnerable populations of important size. Areas and groups that may be vulnerable to food crisis in 1989 include the oases and southeastern areas that have suffered crop damage, the Touareg population of Bassikounou and Fassala Nere (Hodh ech Chargui Region), the southern border area between Brakna and Assaba regions, the town of Doubel Doubaye (Gorgol Region), Hodh Gharbi Region, and as yet unidentified areas of Assaba Region where flooding destroyed dams, thereby disrupting agriculture.

Lean Season Food Aid Distributions, 1988

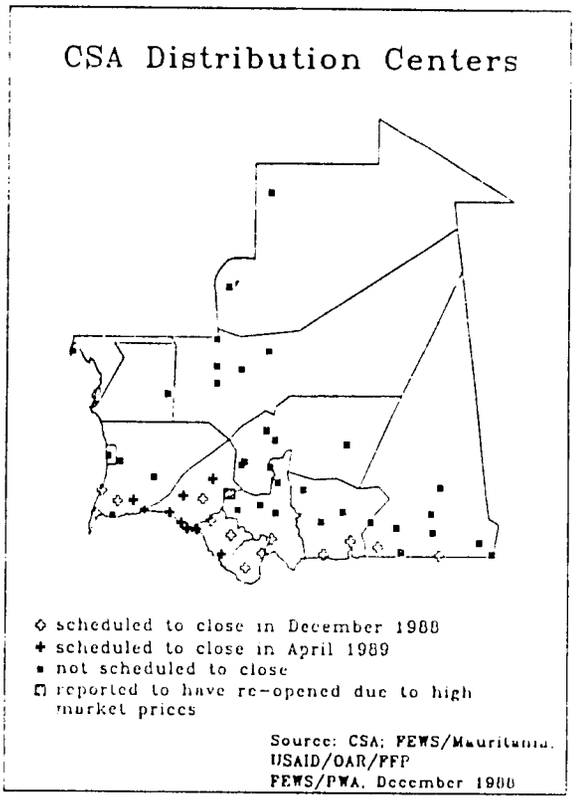
Not as much food aid was distributed during 1988 as had been scheduled. The programs most affected were free distributions and "other" food-for-work (community and national programs -- see Table 1). The prime reason for the shortfall was a truckers' strike during the late spring, which impeded the transport of stocks to the interior and delayed the start of distributions by two months (until September). While available records show that 9,670 MT of free cereals were distributed to those in need during 1988, FEWS/Mauritania considers that actual free distributions may have been closer to 12,000 MT (reporting from some key areas was lacking as of early December). This is still a substantial

Table 1: Scheduled vs Actual Food Aid Distributions and Sales (Cereals), 1987/88

Program	Scheduled Distributions (MT)	Actual Distributions (MT)	Percent of Program Met
CSA Sales	50,555	48,427	95.8%
CSA Free	18,102	9,670	53.4%
CSA FFW	3,585	included in Urban FFW	-
Urban FFW	7,340	9,442	86.4%
Other FFW	6,137	2,082	33.9%
PVOs	556	1,304	234.5%
Total	86,275	70,924	82.2%

Source: FEWS/Mauritania; UNDP; CSA; DOULOS Community; CRS

Map 2:



shortfall from the planned 18,100 MT. There is no information yet as to the consequences of the low levels of free aid actually distributed.

In contrast, the Government of the Islamic Republic of Mauritania (GIRM) Food Security Commission's (CSA) subsidized sales program met 96% of its target (see Appendix 1 for a list of acronyms used in this report). The results imply that some groups, at least, had the wherewithal to purchase grain. It is possible that the original target could have been met, or even surpassed, had deliveries not been delayed by the truckers' strike.

With the rainfed harvest underway and the flood recessional harvest imminent,[1] many CSA warehouses are being closed (see Map 2). The CSA is taking this action in order limit the distortions food aid can place on the cereals market, but is planning to re-open individual centers if the local price of wheat flour surpasses 38 Oughiya (UM) per kilogram (kg). One center is reported to have been re-opened at mid-December based on this trigger (see Map 2).

The highest average per capita distribution of free aid during 1988 was to Brakna Region and the next highest to Trarza Region (13.6 and 9.6 kg, respectively -- see Table 2). The bulk of this aid was provided by Saudi Arabia and shows a response to food crisis indicators: in 1987, Brakna Region experienced a failure of the flood recessional harvest (the total 1987 net per capita production of 15.5 kg is less than a quarter of the 1986 figure for Brakna Region); Brakna Region also experienced severe malnutrition among children in one of its departments (Boghe -- see the reference map in Appendix 2); autumn 1987 nutrition surveys in Trarza found severe malnutrition in some villages in all six departments. When free distributions, sales, and food-for-work (FFW) are combined, the regions receiving the most aid per capita are Adrar and Tiris Zemmour, both of which are non-agricultural (outside of oases) and far from agricultural areas.

Natural Disasters

Mauritania experienced floods during the 1988 rainy season, although not to the extent seen in other parts of the Sahel. At least four towns of significant size suffered destruction of housing (Akjoujt, Boumdeid, el Ghaire, and Djigueni, ranging in size from 1,000 to 8,000 people -- see Map 1), and two deaths were reported at one of these towns (Boumdeid). Emergency aid, including 12 MT of food, was delivered to Akjoujt. It is not clear whether emergency food aid was delivered to the other three towns.

Comparison with June Assessment

The regions that received the most free food aid (Brakna and Trarza) had been cited as containing large numbers of vulnerable areas in the June FEWS Assessment. With sub-region distribution accounts not yet

[1] The several agricultural strategies used in Mauritania center around water: rainfed (dieri) agriculture, in which the only moisture plants receive is from direct rainfall; lowland recession (bas fonds) agriculture, which makes use of temporary ponds created in low-lying areas by runoff and a raised water table; wadi recession (barrage) agriculture, in which wadis are dammed temporarily to catch any runoff from the upper portions of the watershed; flood recession (walo) agriculture, in which crops are planted on flood plains (of the Senegal and other rivers) as the annual floods recede; and irrigated agriculture.

Table 2: Food Aid Distributions and Sales (Cereals), 1987/88

Region	1988 Population[1]	Free Distr[2] (MT)	FFW & Sales[3] (MT)	Total Distr (MT)	Per Capita Free Distr (kg)	Per Cap FFW & Sales (kg)	Per Cap Total Distr (kg)	% Needs Met @ 165 kg/yr[4]	% Needs Met @ 123 kg/yr[4]
Adrar	66,200	4	4,103	4,106	0.1	62.0	62.0	37.6%	50.4%
Assaba	162,330	495	6,760	7,255	3.1	41.6	44.7	27.1%	36.3%
Brakna	191,960	2,604	3,227	5,831	13.6	16.8	30.4	18.4%	24.7%
Dakhlet Nouadhibou	61,060	2	1,167	1,169	0.0	19.1	19.1	11.6%	15.6%
Gorgol	175,250	152	1,955	2,107	0.9	11.2	12.0	7.3%	9.8%
Guidimaka	114,470	236	782	1,018	2.1	6.8	8.9	5.4%	7.2%
Hodh el Gharbi	148,890	541	5,283	5,824	3.6	35.5	39.1	23.7%	31.8%
Hodh ech Chargui	191,790	871	10,519	11,390	4.5	54.8	59.4	36.0%	48.3%
Inchiri	16,480	89	835	924	5.4	50.7	56.1	34.0%	45.6%
Nouakchott	388,400	3,092	13,954	17,045	8.0	35.9	43.9	26.6%	35.7%
Tagant	82,670	549	1,474	2,023	6.6	17.8	24.5	14.8%	19.9%
Tiris Zemmour	31,080	0	1,966	1,966	0.0	63.3	63.3	38.3%	51.4%
Trarza	239,410	2,292	7,927	10,219	9.6	33.1	42.7	25.9%	34.7%
Unspecified		45	0	45					
Total	1,870,000	10,973	59,951	70,924	5.9	32.1	37.9	23.0%	30.8%

Source: FEWS/Mauritania; UNDP; CSA; DOULOS Community; CRS

[1] The population figure used here is based on the 1987 GIRM/CEDS census, rounded to 1,870,000.
[2] This column includes both PVO and CSA distributions. Nutritional stock figures were provided by DOULOS and CRS. The distribution estimate assumes a Saudi Arabian Red Crescent distribution of 1,462 MTs of cereal to Brakna Region and 2,037 MTs to Trarza Region. The estimates are still preliminary, as the Mauritanian Red Crescent had not reported on their stock usage in 1988 at the time of the FEWS/Mauritania December report. The final free CSA distributions were also not available at the time of FEWS/Mauritania's December report -- some CSA centers did not submit distribution figures. November and December 1987 distributions are not included.
[3] FFW statistics were provided by UNDP. Sales and distribution figures were received from the CSA. The final CSA sales figures reflect an annualized estimate based on information for the period January-October, 1988.
[4] The annual per capita consumption rate used in programming food aid is 165 kg. The 123 kg figure is an estimate of per capita consumption in 1986.

available, however, it is not possible to tell what proportion of that aid was distributed to the specific areas cited. The town of Akjoujt was also cited as being highly vulnerable to food crisis in the June report. The town lost its economic base when the local copper mine shut down, and showed increasing levels of child malnutrition over the period from October 1985 to November 1987. At the time of the September 1988 floods, it was discovered that Akjoujt's population numbered only 4,000 people, down from a 1986 population of 11,290 people.

Agricultural Production

Outstanding rainfall within Mauritania and a strong flood of the Senegal River, following excellent rains in Mali and Senegal, have contributed to Mauritania's best agricultural and pastoral year since 1986. In addition, this year's production estimates are more than double any from the years between 1973 and 1985. The method of estimating production was radically changed between 1985 and 1986, however, so that comparisons with the previous period can be misleading.

Production Estimates

According to current estimates, Mauritania will once again experience a record harvest. In fact, the 1988/89 (1988) harvest has a potential for providing 45 to 50% of the country's 1989 food needs, rather than the usual 30%. There is a chance, however, that grasshopper and locust damage will substantially

reduce the harvest. There are two current, pre-grasshopper-damage crop estimates, which differ only in the amount of land estimated to be planted in rainfed crops. The joint FAO/CILSS team estimated a lesser amount of rainfed cropland, leading to a gross production estimate of 181,800 MT of rice, maize, sorghum, and millet. The GIRM Ministry of Rural Development Bureau of Agricultural Statistics (MRD/SSA) estimated gross production to be 204,300 MT.

Both groups took a pessimistic view of this year's lowland and wadi recession harvest potential. Farmers apparently expected the rains to repeat the patterns of the last several years, and so planted the low-lying areas early. Subsequent torrential (for Mauritania) rains drowned these crops, requiring repeat plantings. It remains to be seen whether the crops were re-planted too late to achieve optimal yields, and also just how much acreage was re-planted. In the absence of good data, both groups used the 1987/88 (1987) lowland recession figures to approximate a poor harvest. It might be, however, that the increased flooding of low-lying areas will have actually improved the harvest prospects for lowland recession crops. A more optimistic estimate using 1986/87 (1986) lowland recession production figures would lead to a total gross production of 213,400 MT (starting from the MRD/SSA estimate). The MRD/SSA and more optimistic estimates are shown in Table 3, along with the final crop estimates for 1986 and 1987. These show that the net 1988 production will be at least 25% greater than that of 1987 and some 38% larger than 1986 production. The most remarkable increase in production has been in sorghum, and is directly related to the increase in rainfed production. (The increase in rice production from 1986 to 1987 was caused by the opening of a new irrigation scheme in Gorgol Region.)

Table 3: Summary, 1986 through 1988 Net Production Estimates[1]

	1986/87 (Final)		1987/88 (Final)		1988/89 (MRD/SSA)		1988/89 (FEWS)	
Crop	Area (ha)	Net[2] (mt)	Area (ha)	Net[3] (mt)	Area (ha)	Net[4] (mt)	Area (ha)	Net[5] (mt)
Millet	19,500	11,600	28,700	14,100	23,200	10,900	23,200	10,900
Sorghum	117,600	81,900	115,700	82,900	185,200	118,300	196,800	126,000
Maize	1,800	2,900	600	900	500	1,100	500	1,100
Rice	6,600	19,800	11,300	30,500	12,200	30,600	12,200	30,600
Total	145,500	116,200	156,300	128,400	221,100	160,900	232,700	168,600

Source: GIRM/MRD/SSA

[1] To maintain consistency with previous years' net production estimates, only processing losses are accounted for here. Millet, sorghum and maize production figures were reduced by 15% to account for processing losses; rice production was reduced by 40%. In estimating cereal balances below, seed and feed requirements are also removed to arrive at a reduced net production figure.
[2] 1986/87 estimate: MRD/SSA, May 1987.
[3] 1987/88 estimate: MRD/SSA, March 1988.
[4] 1988/89 estimate 1: MRD/SSA, November 1988.
[5] 1988/89 estimate 2: area of lowland and wadi production increased to match that of 1986/87 per the May 1987 MRD/SSA assessment of 1986/87 production.

There have been dramatic inter-annual shifts in Mauritania's regional production over the past three years that are not apparent from the summary statistics (see Table 4). Most striking are the inter-annual comparisons for Assaba, Brakna, and Guidimaka regions. This year's production for these regions is five and six times the size of last year's, but only one to two times that of 1986, underscoring the poverty of these regions' 1987 harvests. The differences lie in three of the agricultural strategies used in these regions. During 1986, there was no rainfed harvest in Brakna and Assaba regions and a minimal rainfed harvest in

Table 4: 1988/89 Net[1] Production per Region

Region	1988/89 MRD/SSA[2] (mt)	1988/89 FEWS[3] (mt)	MRD 88 v MRD 86[4]	MRD 88 v MRD 87[5]	FEWS 88 v MRD 86	FEWS 88 v MRD 87
Adrar	0	0				
Assaba	8,180	9,430	111.6%	649.1%	128.6%	748.2%
Brakna	14,960	15,510	132.0%	514.0%	136.8%	532.9%
Dakhlet Nouadhibou	0	0				
Gorgol	48,190	51,480	121.5%	158.8%	129.8%	169.6%
Guidimaka	12,650	13,720	179.2%	583.1%	194.3%	632.3%
Hodh ech Chargui	38,500	39,270	173.2%	74.5%	176.7%	76.0%
Hodh el Gharbi	10,150	10,450	112.6%	49.5%	115.8%	50.9%
Inchiri	0	0				
Nouakchott	0	0				
Tagant	440	960	11.8%	85.3%	25.6%	184.9%
Tiris Zemmour	0	0				
Trarza	27,850	27,850	198.0%	146.4%	198.0%	146.4%
Total	160,920	168,670	138.4%	125.3%	145.1%	131.3%

Source: GIRM/MRD/SSA; FAO/CILSS

1 To maintain consistency with previous years' net production estimates, only processing losses are accounted for here. Millet, sorghum and maize production figures were reduced by 15% to account for processing losses; rice production was reduced by 40%. In estimating cereal balances below, seed and feed requirements are also removed to arrive at a reduced net production figure.

2 1988/89 estimate 1: November 1988 MRD/SSA estimate (including regional breakout for rainfed and irrigated crops), with lowland, wadi, and flood recessional crops broken out according to the Fall 1986 FAO/CILSS Regional assessment.

3 1988/89 estimate 2: November 1988 MRD/SSA estimate with the area of lowland and wadi production increased to match that of 1986/87 per the May 1987 MRD/SSA total, broken out according to the Fall 1986 FAO/CILSS Regional assessment.

4 1986/87 estimate: May 1987 MRD/SSA estimate broken out according to the Fall 1986 FAO/CILSS Regional assessment.

5 1987/88 estimate: March 1988 MRD/SSA estimate broken out according to the Fall 1986 FAO/CILSS Regional assessment.

Guidimaka, although the lowland recession harvest was strong in all three regions and Brakna Region saw a mediocre flood recession harvest. During 1987, rainfed crops showed a similar pattern to that of 1986. The lowland recession harvest was abysmal in all three regions, however, and the flood recession harvest failed in Brakna. In 1988, all three regions will have substantial rainfed crops, and Brakna Region will have an outstanding flood recession harvest. Only the lowland recession harvest may be poor. Unfortunately, even with this year's increases, Brakna and Assaba regions have produced less than half the cereals needed locally (at the annual consumption rate of 165 kg per person, see Map 3).

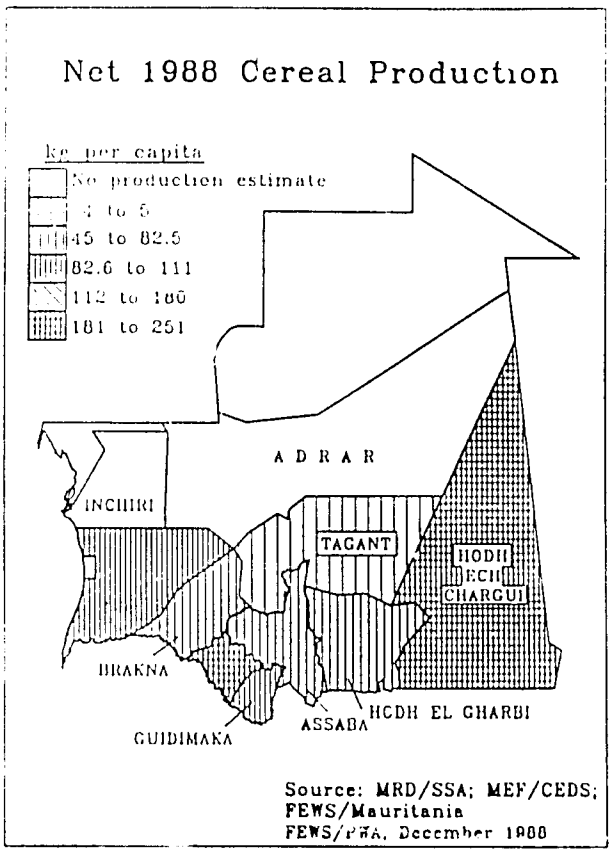
The strong decline in production since 1987 in Hodh ech Chargui and Hodh el Gharbi regions might be cause for concern. On a per capita basis, the current harvest is actually quite strong in Hodh ech

Chargui Region. Hodh el Gharbi, however, appears to have also grown less than half the food required for its population for 1989. In addition, this year's production in Hodh el Gharbi is only somewhat better than that of 1986, and 1986 saw a crop failure in the area of Touil that caused the entire community to leave in search of food or work.

Tagant Region is another area where production may have declined from last year,[1] and certainly has declined from the year prior to that. Per capita production in this pastoral area is the lowest among the regions for which crop production estimates are made.

Adrar and Inchiri regions were apparently not included in the 1988 harvest assessment, repeating last year's practice. In 1986, however, these two regions together produced about 2,360 MT of wadi and lowland recession sorghum, compared to Tagant Region's 3,200 MT. While it may not be appropriate to apply the same proportions for the 1988 harvest, production did occur in these regions, probably at a lower per capita rate than in Tagant. Wheat and barley are also grown at oases in all three of these regions, but are not included in the annual harvest assessment.

Map 3:



Pasturage

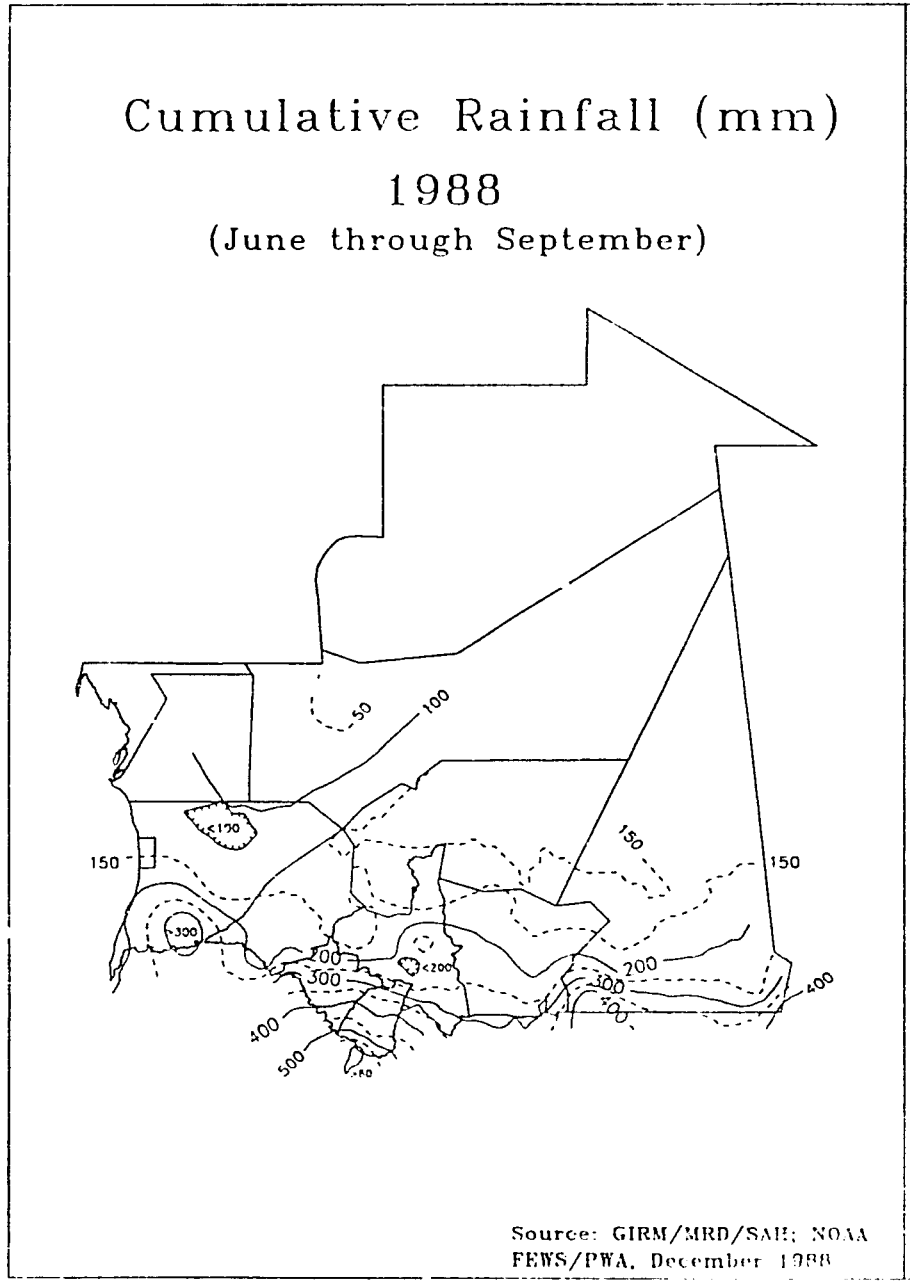
Following explosive growth in August, pasturage in the southeast was reported to be very dense, which is important in this predominantly pastoral country. Pastures were also relatively strong in south-central and southwestern areas. The grasslands stretched further north than in the recent past, reaching a line from Oualata to Tamchekket to Moudjeria to Boutilimit (see Map 1), and there have been reports of plant species not seen for years. The pastures began drying in October after the end of the rains in late September. By the end of that month, 70% of the pasturage was dry in Hodh ech Chargui, Hodh el Gharbi, Assaba, Guidimaka, Gorgol, and Brakna regions, although grasses still remained in inter-dunal depressions in the southwest. Scattered winter pastures were reported to have begun by early October in the far north of the country and, by inference from satellite imagery, in neighboring Western Sahara.

Rainfall and Vegetation

Rainfall and satellite vegetation data support the picture of improved rainfed agriculture and vastly improved pasture lands. The data also provide an idea of the possible intra-regional distribution of the 1988 rainfed agriculture and pasture. While the rains did not begin until mid or late July in most of the rainfed areas, the total cumulation was significant in 1988. According to the CPS, areas that have received at least 200 millimeters (mm) of rain should have luxurious pastures. Areas with at least 150 mm would still have potential for some pasture. In 1988, all of Mauritania's southern tier received at least 150 mm of rain (see Map 4).

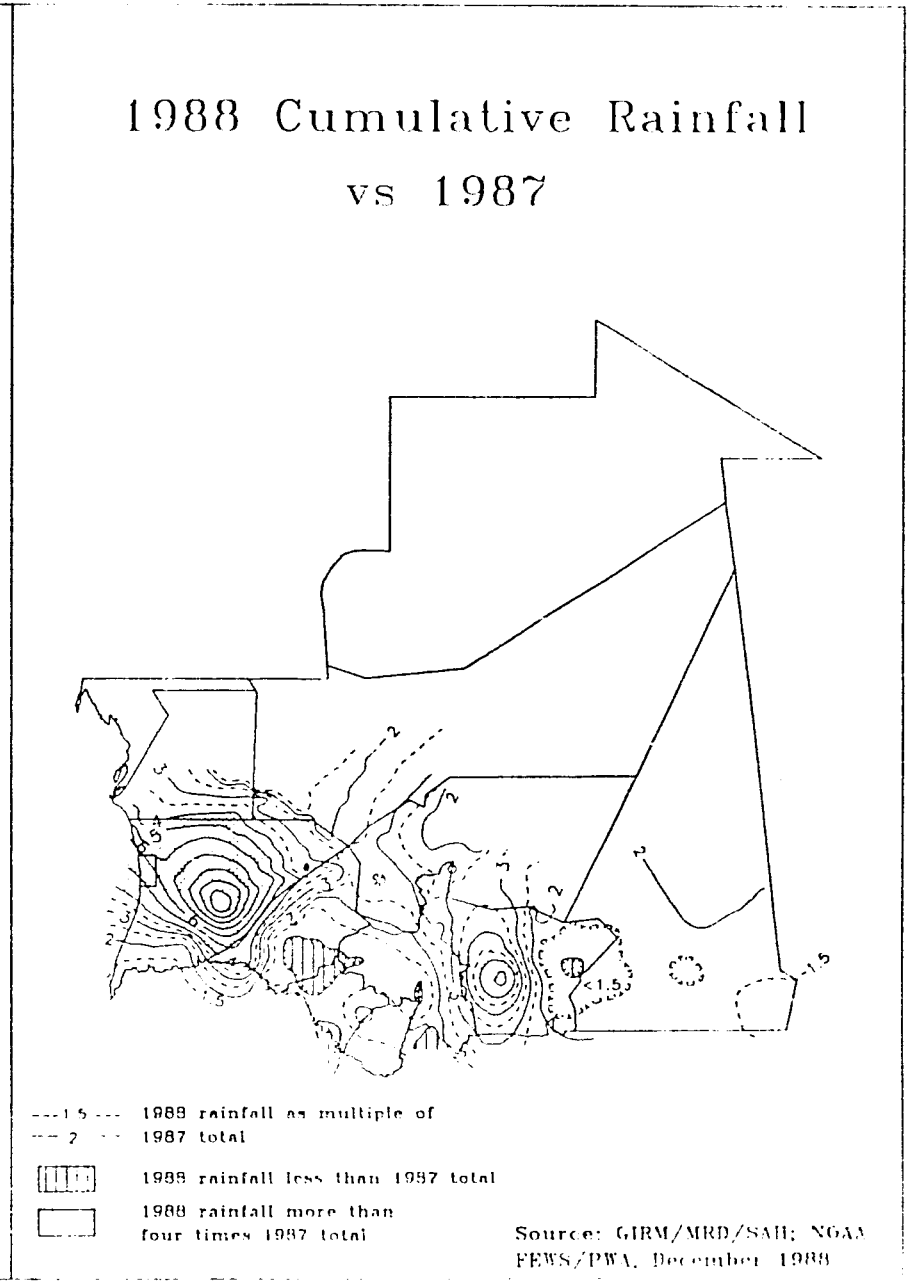
[1] The only crops assessed in Tagant are wadi and lowland recession sorghum. As mentioned above, FAO/CILSS and the MRD/SSA are using the 1987 area planted for these two crop types, while this report suggests that the 1986 area planted might be appropriate.

Map 4:



Source: GIRM/MRD/SAH; NOAA
FEWS/PWA, December 1988

Map 5:



Source: GIRM/MRD/SAH; NOAA
FEWS/PWA, December 1988

Areas where cumulative rainfall is greater than 300 mm have the best potential for successful rainfed agriculture. In 1988, such areas covered a spot in southern Trarza Region, much of Guidimaka and Gorgol regions, the southern tip of Assaba Region, and a strip along the southern border of Hodh ech Chargui Region (see Map 4). Rainfed agriculture is possible with only 200 mm of rainfall if the rains are spaced well. A great deal more territory lies within the 1988 200 mm-or-greater zone, including much of Hodh el Gharbi, Assaba, and Trarza regions. Among the southern regions, however, Brakna appears to contain little territory that received enough precipitation for rainfed agriculture.

Most of Mauritania received better rainfall in 1988 than in 1987 (see Map 5). The extreme improvements in central Trarza and western Hodh el Gharbi regions are a reflection of the very poor rains in these areas in 1987. This assessment is supported by the fact that 1988 rainfall in these areas was moderately better than the 1985-1987 average (see Map 6) and about the same as the long-term average (see Map 7). The zone around Nouakchott, however, has received an unusually large amount of rain, although barely enough to support grasses. The largest area showing less rainfall in 1988 than in 1987 is eastern Brakna and northwestern Gorgol regions. A nearby (and slightly overlapping) area shows less rainfall in 1988 than for the average of 1985 through 1987. When compared to the long-term, a much broader zone of less-than-average appears. Within that zone is an area showing less than three-quarters of the long-term average, which may indicate trouble for any agriculturalists that might live there.

The satellite-derived vegetation information (Normalized Difference Vegetation Index, or NDVI -- see inside of back cover) shows a picture that is not identical to that derived from rainfall data (see Maps 8 through 10). The level of vegetation that should correspond to grasslands is both lacking in spots within the 200 mm isohyet and present to the north of that line (see Map 8). Also, from the way the isohyets run in the southeast (Map 4), one would expect the higher vegetation levels to be concentrated in Hodh ech Chargui Region rather than in its western neighbor, Hodh el Gharbi. Possible reasons for the differences include: 1) the spatial distribution of rain stations used may not be dense enough to accurately describe local variations in rainfall; 2) the rain stations' spatial distribution may also affect the rainfall distribution patterns generated by the trend surface; 3) different soils (and other geological features) vary in the degree to which they can support vegetation, even with good rains; 4) spatial variations in temperature, affecting evapo-transpiration rates, may encourage vegetative growth in some areas while discouraging such growth in others. There are still strong similarities between the two pictures. The northern boundary of vegetation is at about the same latitude as that of the 200 mm line, and both the rainfall and vegetation data indicate a lack of grassland potential in Brakna Region.

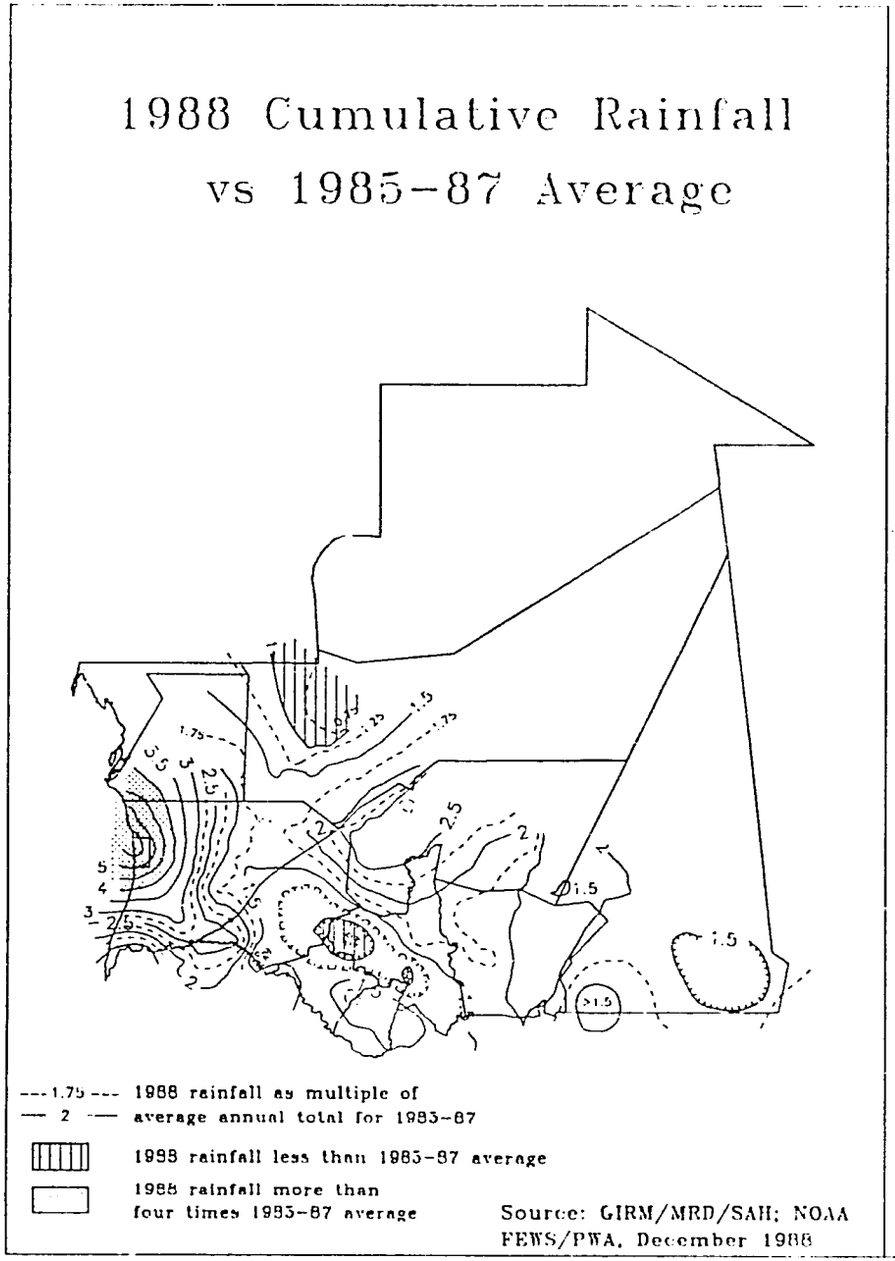
The areas where 1988 vegetation was stronger than in 1987 lie predominantly in Mauritania's pastoral zone (see Map 9), while those that are better than average cover the bulk of vegetated Mauritania (see Map 10). This evidence supports the reports of unusually widespread pasture compared to recent years.

Other Factors Affecting Production

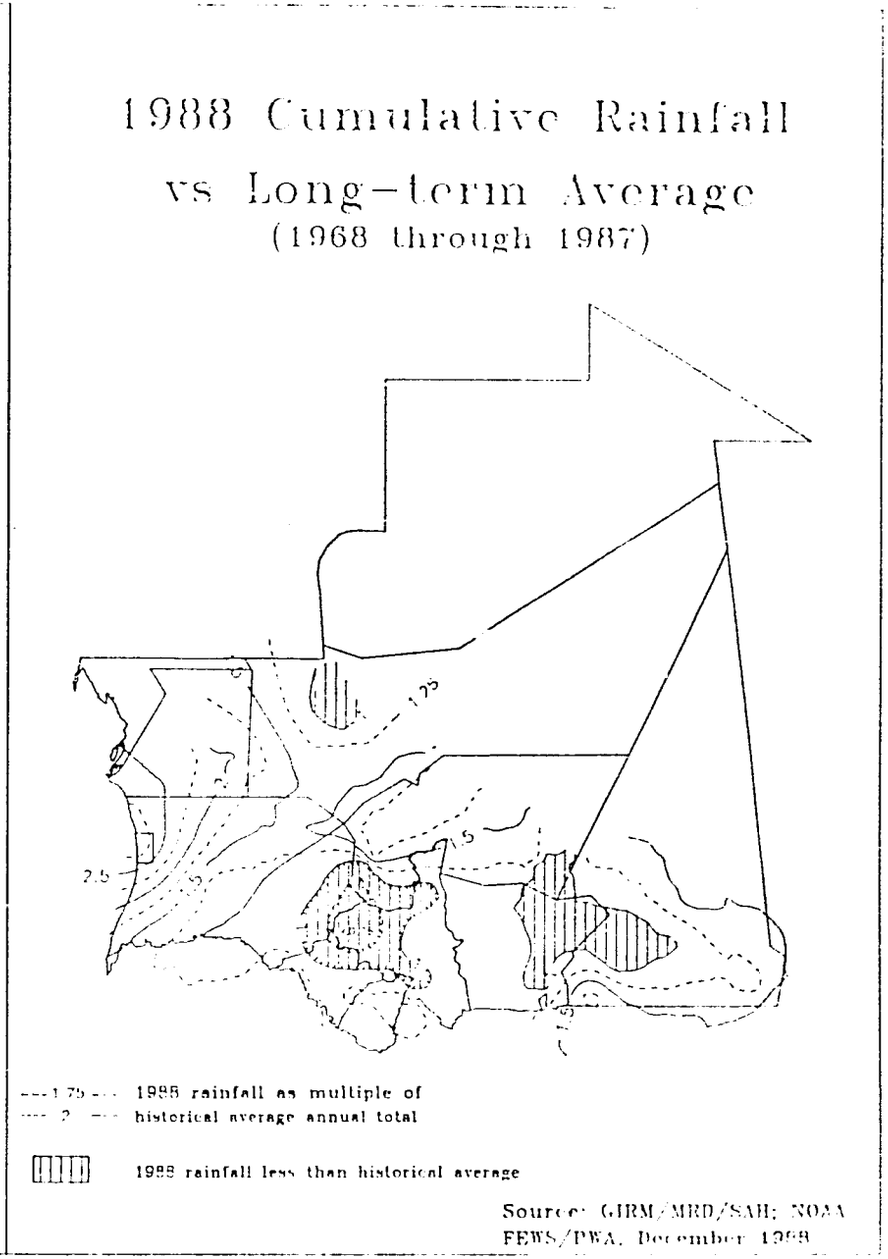
The 1988 flood of the Senegal River has had a strongly positive effect on crop production. On the other hand, infestations by Desert Locusts and Senegalese Grasshoppers and flood damage to traditional dams on inland wadis may have caused significant crop damage.

The Senegal's strong flood this year has helped produce at least 50,000 hectares (ha) of flood recessional agriculture, up from 24,000 ha in 1987. The Senegal flood affects harvests in Trarza, Brakna, and Gorgol regions. Unfortunately, flood recessional crop yields may not be optimal this year, as river levels dropped quickly after cresting at mid-September. The quick drop will have prevented the 25 to 40 days of flood that are required for the best results. A major water release in October from the upstream Manantali Dam (in Mali) may have counteracted the natural drop somewhat, maintaining the flood for a longer period. The effects on the flood of that release have not yet been reported.

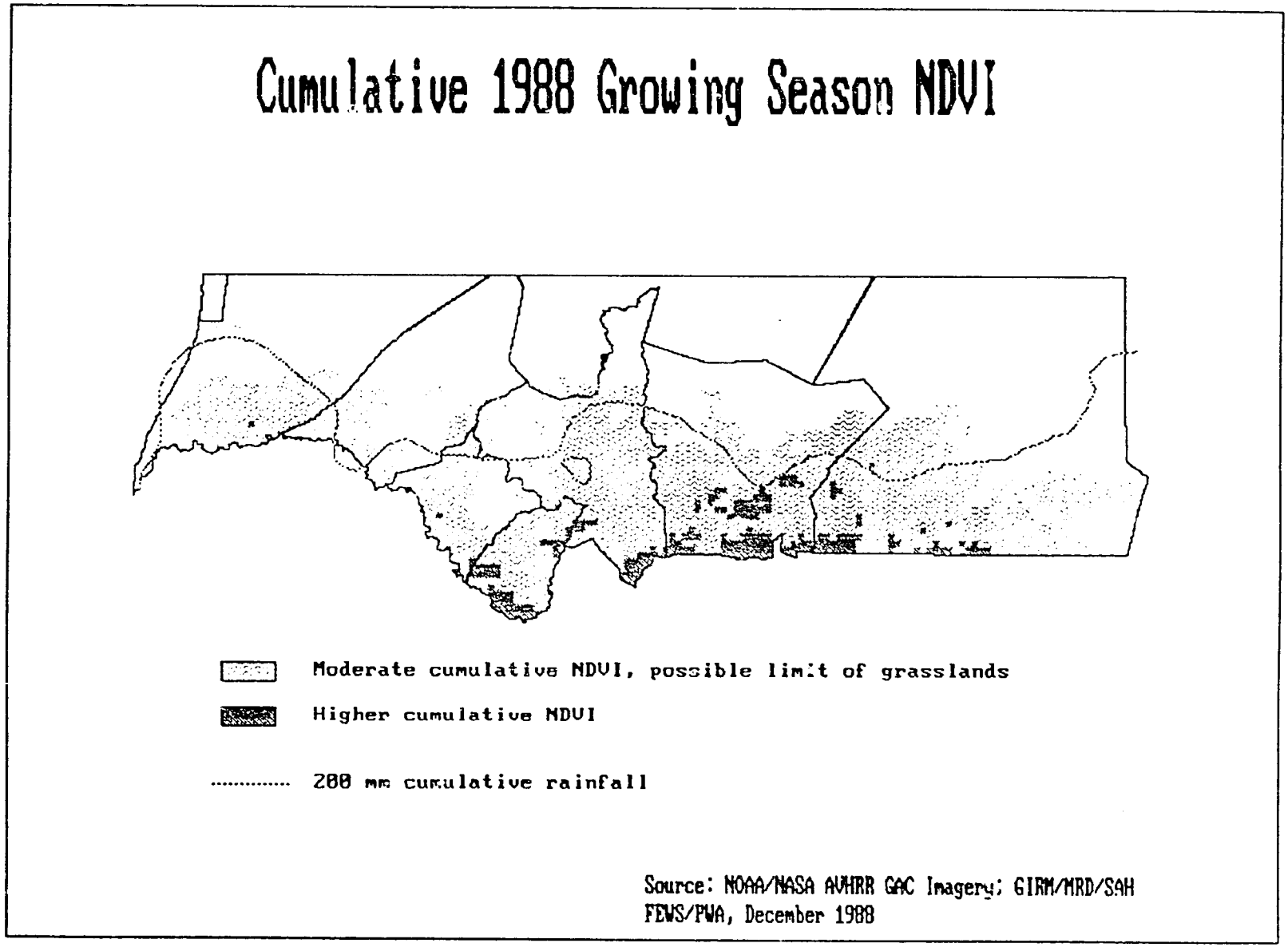
Map 6:


1988 Cumulative Rainfall
vs 1985-87 Average
---1.75--- 1988 rainfall as multiple of
— 2 — average annual total for 1985-87
1988 rainfall less than 1985-87 average
1988 rainfall more than
four times 1985-87 average
Source: GIRM/MRD/SAH; NOAA
FEWS/PWA, December 1988

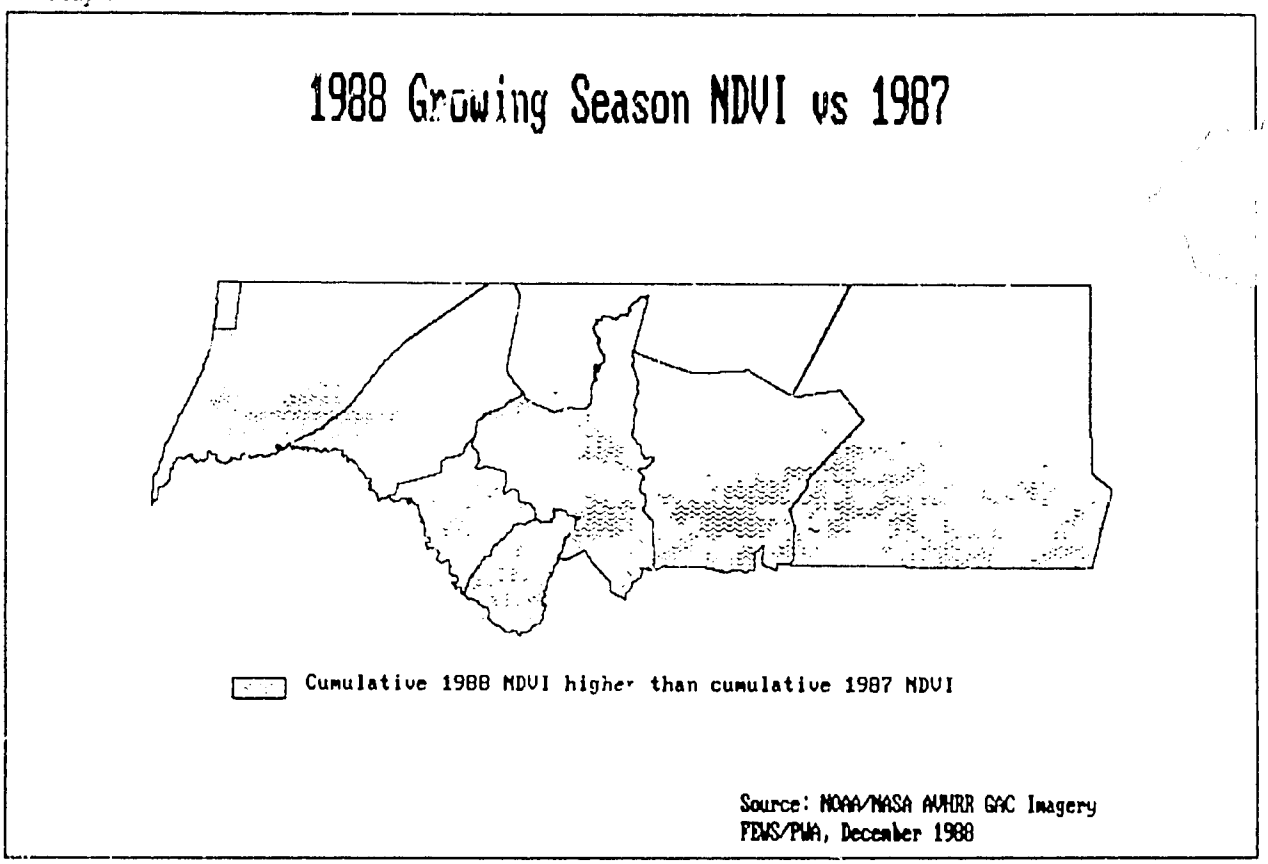
Map 7:


1988 Cumulative Rainfall
vs Long-term Average
(1968 through 1987)
---1.75--- 1988 rainfall as multiple of
---2--- historical average annual total
1988 rainfall less than historical average
Source: GIRM/MRD/SAH; NOAA
FEWS/PWA, December 1988

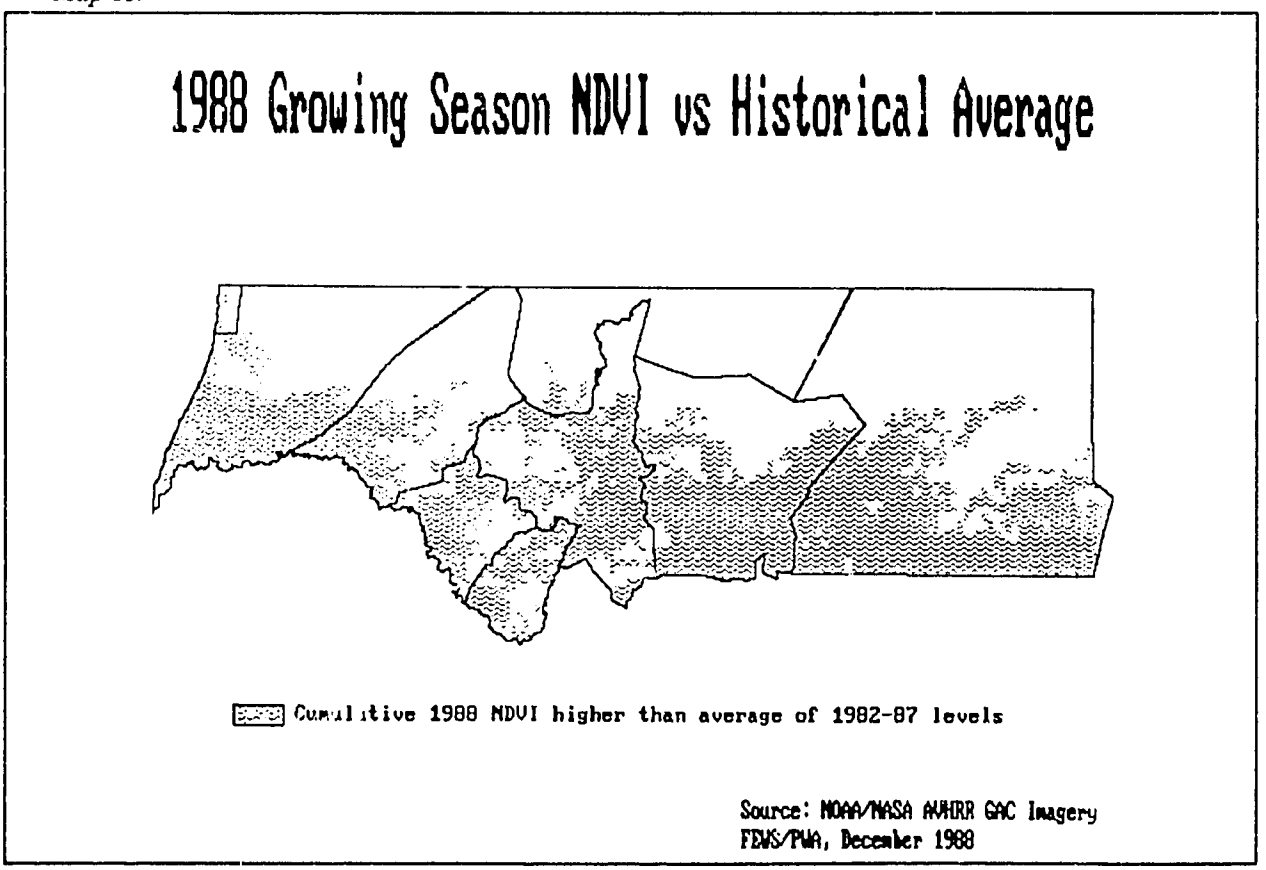
Map 8:


Cumulative 1988 Growing Season NDVI
Moderate cumulative NDVI, possible limit of grasslands
Higher cumulative NDVI
200 mm cumulative rainfall
Source: NOAA/NASA AVHRR GAC Imagery; GIRM/MRD/SAH
FEWS/PWA, December 1988

Map 9:

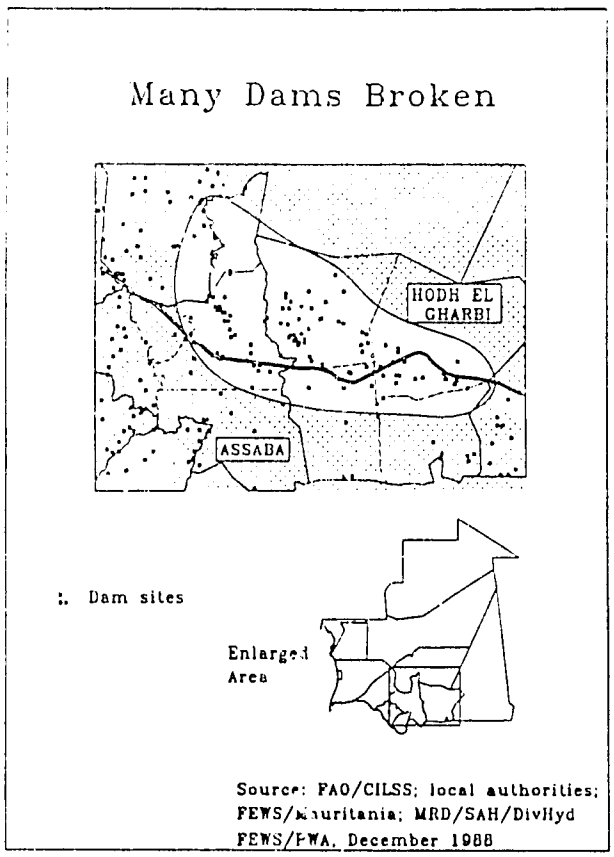

1988 Growing Season NDVI vs 1987
Cumulative 1988 NDVI higher than cumulative 1987 NDVI
Source: NOAA/NASA AVHRR GAC Imagery
FEWS/PWA, December 1988

Map 10:


1988 Growing Season NDVI vs Historical Average
Cumulative 1988 NDVI higher than average of 1982-87 levels
Source: NOAA/NASA AVHRR GAC Imagery
FEWS/PWA, December 1988

As noted above, this year's rain was much heavier than in recent years, especially in central Trarza and western Hodh el Gharbi regions (see Maps 5 and 6). While the increased rains have allowed an expansion of rainfed agriculture (especially south of the 16th parallel), local authorities in Hodh el Gharbi Region reported to the FAO/CILSS harvest assessment team that the relatively heavy rains have damaged some 40% of the region's traditional dams (see Map 11 for dam locations). Wadi recessional agriculture may contribute only 3% of Hodh el Gharbi's cereal production (the most recent regional estimates of recessional agriculture were made in 1986 -- it is possible that 1988 patterns would not be identical). It is, however, the only source of local cereals in the northern part of the region. Many dams in northern Assaba Region are also reported to have been damaged by floods. While specific details about the damage are not known, wadi and lowland agriculture provide about 15% of the harvest in Assaba Region.

Map 11:

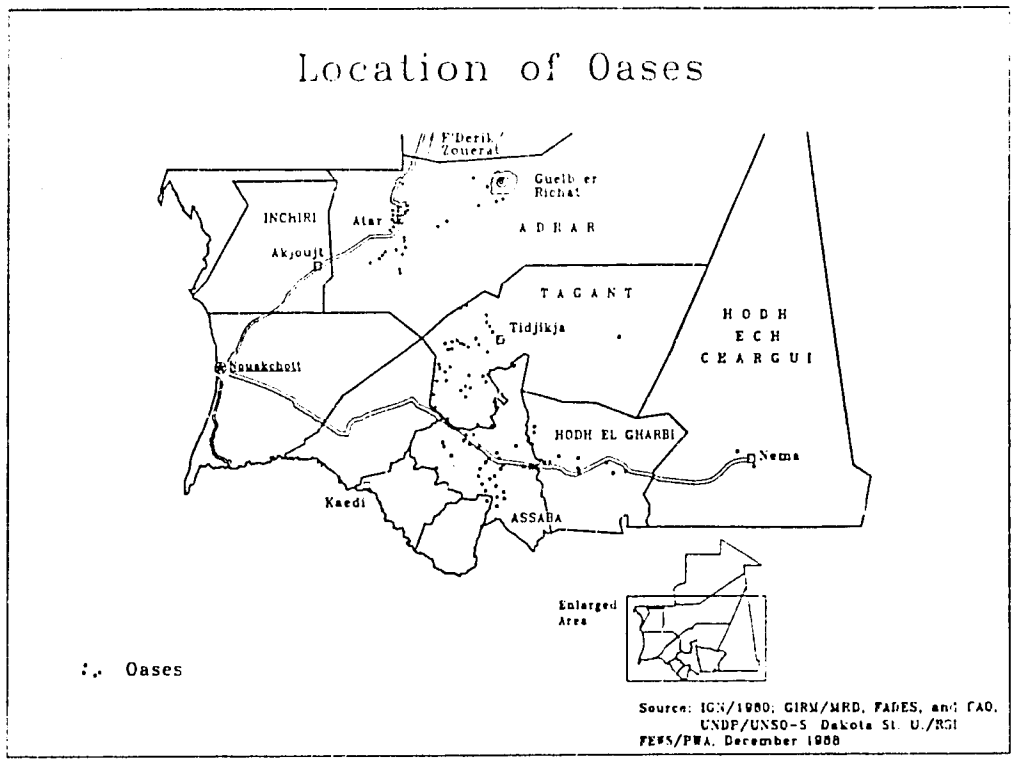


Oasis areas in Tagant, Assaba, Adrar, and Inchiri regions were under renewed attack by Desert Locusts in November and early December (see Map 12 for oasis locations -- locations in Inchiri are not known). These oasis areas have experienced locust infestations since early 1988. Oases in Tagant and Adrar regions have been under particular attack. While cereal production in these two regions does not contribute a large amount to the national total, it is important to the local population. The number of people residing at oases at Adrar and Tagant regions are estimated to be 15,900 and 20,600 people, respectively. (These estimates do not reflect migration from oases to Nouakchott since the 1984 drought.) The degree to which oasis populations can cope with a loss of cereal crops will depend in part on the ease of commerce between these areas and the more grain-rich areas in the south. The extent of the primary road network (paved only as far north as Akjoujt) would suggest that commerce between these areas is not easy.

In other parts of the country, Desert Locusts have tended to remain in native vegetation rather than attacking crops. There were exceptions to this in southwestern Trarza Region -- reported early crop damage ranged from 10 to 60% of cereals in the various villages surveyed. It remains to be seen whether crops were replanted in time to achieve full yields. In the southeast, the grasslands were so abundant that there was no real competition between the locusts and livestock. Reports from the north indicate that vegetation emerging in early October was severely attacked, although some plant species regenerated following rains in the second week of November. The danger in the north is not so much to Mauritania's pastoralists as to Moroccan and Algerian agriculture, and subsequently to the rest of North Africa and to the Near East -- northern Mauritania (and neighboring Western Sahara) serves as a winter breeding zone for Desert Locusts. Logistical problems in Mauritania, compounded by security problems in Western Sahara, make locust control in the north singularly difficult.

Grasshoppers actually caused much more crop damage in Mauritania this year than have Desert Locusts. As pastures declined during November, grasshoppers moved into crop areas in Tagant, Assaba, and southeastern Hodh ech Chargui regions. The CPS reports that as much as 60% of the rainfed crop has been lost to grasshoppers. (Rainfed farming is the main form of agriculture practiced in Hodh ech Chargui

Map 12:



Region.) USAID and other donor groups involved in the locust/grasshopper control program believe that the CPS has overestimated crop losses. The United Nations World Food Program (WFP) has been using losses between 20 and 25% when making rough, unofficial estimates of the implications of grasshopper and locust damage. USAID has calculated cereal balances for 1989 using both no crop loss and a 30% crop loss to bracket the range of possible damage.

Food Security

Mauritania will have enough cereal to meet its 1989 food needs, after combining the net 1988 harvest, carry-over stocks from 1988, expected commercial imports, and expected aid. In spite of the strong overall cereals position, there are areas that will require food aid during the 1989 lean season. Depending on the actual degree of pest damage, there may or may not be a carry-over stock available for 1990 (the envisioned carry-over stock would contain no CSA stocks). Because the rains in Mauritania are so unpredictable, carry-over stock is required as a hedge against future crop failure. More complete information about the 1988 pest damage is required in order to judge whether the security stock for 1990 is threatened.

Food Stocks and Cereal Balance

If pest damage in 1988 turns out to have been minimal, Mauritania should have ample food for its 1989 needs (see Table 5). The cereal balance estimates shown in Table 5 include population, imports, stocks, and consumption estimates that were agreed upon by the CSA and the donor community, the November MRD/SSA production estimate, and the further production estimate posited above. The balances were calculated under the assumption that locust and grasshopper damage would be minimal. Cereal balance estimates that include assumptions of 10, 15, and 30% crop loss to pests can be found in Appendix 3. Using the MRD/SSA production estimate, Mauritania would still "break even" with regard to its cereal needs even if 10% of the crop were lost to pests. If 30% of the MRD/SSA estimate were lost, however, Mauritania would enter 1990 with a security stock of only 1,300 MT. If one

Table 5: Cereal Balance Estimates for 1989, Assuming No Crop Loss from Locusts[1]

1989 Population = 1,926,000	MRD/SSA Prd Est		FEWS Prd Est	
Gross Production	204,300		213,400	
Seed	(2,700)		(2,700)	
Feed	(8,000)		(8,000)	
Processing Losses	(41,600)		(43,000)	
Net Production		152,000		159,700
Carry-Over Stock from 1988				
On-Farm	10,000		10,000	
Private Merchants	6,000		6,000	
CSA	26,897		26,897	
SONIMEX	6,191		6,191	
Total Carry-Over Stock		49,100		49,100
Pledged Food Aid				
Free Distribution, FFW, & PVO	12,000		12,000	
For Sale	49,000		49,000	
Total Pledged Aid		61,000		61,000
Expected Cereal Imports				
SONIMEX	65,000		65,000	
Commercial	40,000		40,000	
Total Expected Imports		105,000		105,000
Total Supply Estimate		367,100		374,800
Per Capita Annual Consumption		165 kg		165 kg
Projected Consumption		(317,800)		(317,800)
Cereal Balance Estimate		49,300		57,000
% Consumption needs met by Total Supply Estimate		115.5%		117.9%
Proposed Reconstitution Stocks				
On-Farm	(10,000)		(10,000)	
Private Commercial	(6,000)		(6,000)	
Security Stock (CSA)	0		0	
Other (SONIMEX)	(16,500)		(16,500)	
Total Proposed		(32,500)		(32,500)
Balance After Stocks Reconstituted		16,800		24,500

Source: FEWS/Mauritania; MEF/CEDS; MRD/SSA; SONIMEX; CSA; WFP/Mauritania; FAO/Mauritania; USAID/Mauritania

[1] See Appendix 3 for details on data sources and for further balance estimates based on different crop loss and consumption rate hypotheses.

assumes that the FEWS production estimate were true, a loss of 15% of that amount to locusts and grasshoppers would still leave the country with its 32,500 MT security stock. Similarly, a 30% crop loss based on the FEWS estimate would result in 6,800 MT carryover into 1990, which would still be quite inadequate if the 1989 rains were poor.

According to national estimates, Mauritania had 49,100 MT of carry-over stocks going into the 1988/89 (1989) food planning year (November to October), indicating a 23,700 MT shortfall in actual consumption among the country's population during 1988. This shortfall may be in part an artifact of the assumptions made about on-farm and private carry-over stocks. Also, the per capita annual consumption requirement used in calculating cereal needs (165 kg) is based on general assumptions about nutrition needs, rather than on studies of consumption patterns in Mauritania (a fairly costly process). The average per capita cereal requirement in this largely pastoral country may actually be much lower. Among pastoral populations, the 1988 shortfall, if real, was probably eased by greatly increased access to milk products afforded by strong pastures, which allowed herds to be kept close by.

Per capita production varies a great deal among the agricultural regions, as noted above. Only Gorgol and Hodh ech Chargui regions produced more than was locally needed in 1988, while Trarza and Guidimaka were the only regions among those remaining to produce more than 60% of local needs (see Table 6). Because Mauritania is heavily pastoral, however, low per capita cereal production alone is not sufficient to raise a flag about a particular area's food security -- the people of that area may normally consume far less than 165 kg per year, and they also may have the means to purchase needed grain. In addition to local cereal production, information is needed on the degree to which the population in an area depends on agriculture versus herding or commercial endeavors, the success of the herding or commercial endeavors, and the local availability of commercial and public food stocks.

The people of regions for which there are no cereal production estimates depend on herding, mining or other industry, or oasis agriculture. Tagant Region is also predominantly pastoralist. Assaba, Brakna, Trarza, Guidimaka, Hodh ech Chargui, and Hodh el Gharbi regions contain significant farming populations, although data is not yet available from the most recent census (1987) to determine their share in the overall region populations. Households that depend on herding should be fairly well off at this point, considering the glowing reports about 1988 pastures. FEWS has not researched the health of the iron mine or other industries.

Areas of Concern

There are a few localized areas of concern regarding the populations' level of food security (see Map 1). While estimates have been made of the populations of some of these areas, the percentage of the population that might experience food crisis is as yet unknown.

- The decline from last year in Hodh el Gharbi's per capita production could be a sign of trouble for the population that is dependent on farming. For the pastoral population, the production decline may merely indicate an increased need for capital with which to obtain cereals from the market.

- The area of much-lower-than-normal rainfall in eastern Brakna and western Assaba regions may signal trouble for pastoralists. Any farmers should have little trouble, as they would practice wadi recessional agriculture, rather than rainfed agriculture. Wadi recessional agriculture does not depend solely on local rainfall.

- Some oases may be in trouble, especially in Tagant and Adrar regions, following repeated Desert Locust infestations over the course of 1988. The oasis populations in Tagant and Adrar regions are tentatively estimated to total 36,500 people. The oases in Assaba, Hodh ech Chargui, Hodh el Gharbi, and Inchiri regions are of lesser concern. The oasis populations of Assaba and the Hodhs total about

Table 6: 1989 Food Needs Met by Local Cereal Production; Several Scenarios

Region	1989 Pop[1]	Net 88 Production after Seed, Feed, & Processing[2]		Per Capita Net 88 Production		Percent Needs Met Progmg Consump Rate[3] (165 kg/yr)		1986 Consump Rate[4] (123 kg/yr)	
		MRD/SSA (mt)	FEWS (mt)	MRD/SSA (kg)	FEWS (kg)	MRD/SSA	FEWS	MRD/SSA	FEWS
Adrar	68,190	0	0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Assaba	167,190	7,640	8,840	45.7	52.9	27.7%	32.0%	37.2%	43.0%
Brakna	197,710	14,090	14,660	71.3	74.1	43.2%	44.9%	57.9%	60.3%
Dakhlet Nouadhibou	62,890	0	0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Gorgol	180,500	45,270	48,500	250.8	268.7	152.0%	162.8%	203.9%	218.5%
Guidimaka	117,900	11,830	12,880	100.3	109.2	60.8%	66.2%	81.6%	88.8%
Hodh ech Chargui	197,540	35,980	36,840	182.1	186.5	110.4%	113.0%	148.1%	151.6%
Hodh el Gharbi	153,350	9,490	9,800	61.9	63.9	37.5%	38.7%	50.3%	52.0%
Inchiri	16,970	0	0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Nouakchott	400,040	0	0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Tagant	85,150	410	900	4.8	10.6	2.9%	6.4%	3.9%	8.6%
Tiris Zemmour	32,010	0	0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
Trarza	246,580	27,280	27,310	110.6	110.8	67.1%	67.1%	89.9%	90.0%
Total	1,926,000	151,990	159,730	78.9	82.9	47.8%	50.3%	64.2%	67.4%

Source: FEWS/Mauritania; MEF/CEDS; MRD/SSA

1 The 1989 population figure is based on a preliminary estimate from the MEF/CEDS 1987 census. The original CEDS figure was rounded to 1,870,000 and then increased at an annual growth rate of 3.0%.

2 Cereals accounted for here are maize, millet, rice, and sorghum. Net production assumes 2,700 MT of all four types to be reserved for seed; 8,000 MT of maize, millet, and sorghum to be reserved for animal feed; processing losses for maize, millet, and sorghum to be 15% of the remainder; and processing losses for rice to be 40% of the remainder.

3 The GIRM and all of the donor groups use an annual per capita consumption rate of 165 kg of cereals when programming food needs.

4 The 1986 consumption rate was estimated during 1986 by FEWS/Mauritania.

89,800 people. Inchiri Region's oasis population is not known. Besides the problem of lost cereal crops, the locusts may have caused serious damage to the date palms, which are the mainstay of oasis economies and contribute significantly to the national economy. Further information about the pest damage would help to clarify the situation.

- Despite the high per capita production figure for Hodh ech Chargui Region, significant crop damage has been reported in the southeast of the region by both the CPS and the WFP. The population in the affected area totals about 83,900 people. The food insecurity of individual households will be partly determined by the amount of stock that was on-hand at the start of the 1988 growing season. The populations of Bassikounou and Fassala Nere had rather low stocks at that time.

- A further group of concern in this region is that of destitute Touareg families that have apparently settled in the area of Bassikounou and Fassala Nere. The group numbers about 1,500 people.

In addition to these areas, individual villages throughout Mauritania have been hard hit by locust and grasshopper damage. A prime example of this is the village of Doubel Doubaye, in Gorgol Region, where there will be no crop -- farmers abandoned their infested fields earlier in the year. This village had no harvest in 1987 because the Senegal River did not flood. It could be that villagers did not have enough seed to continue re-planting, or that the window of opportunity had passed for planting crops that would mature.

While there is no systematic, periodic, bottom-up reporting scheme in Mauritania with which to track such information, the CSA does coordinate an annual series of risk-assessment missions immediately following the harvest of rainfed crops. This year's missions, when combined with the sought after second FAO/CILSS assessment mission and the final MRD harvest assessment, should pinpoint any trouble spots. Considering the strength of the 1988 rains and their effect on crops and pastures, any further trouble spots should indeed be pinpoints.

Comparison with June 1988 Assessment

Because of the good 1988 rains, many of the areas pegged as being highly vulnerable to food crisis in 1988 have fared fairly well, especially the flood recessional zone of Brakna Region. Even so, many of the areas cited in the immediately preceding section were also cited in June as being highly or moderately vulnerable, including southeastern Hodh ech Chargui Region, the Touareg population, and the area that surrounds Doubel Doubaye. While the reason for citation in June was a lack of rainfall or flood in 1987, the main cause of the current assessment is the presence of enough rain to have provided a good habitat for locusts and grasshoppers.

Long-Term Outlook

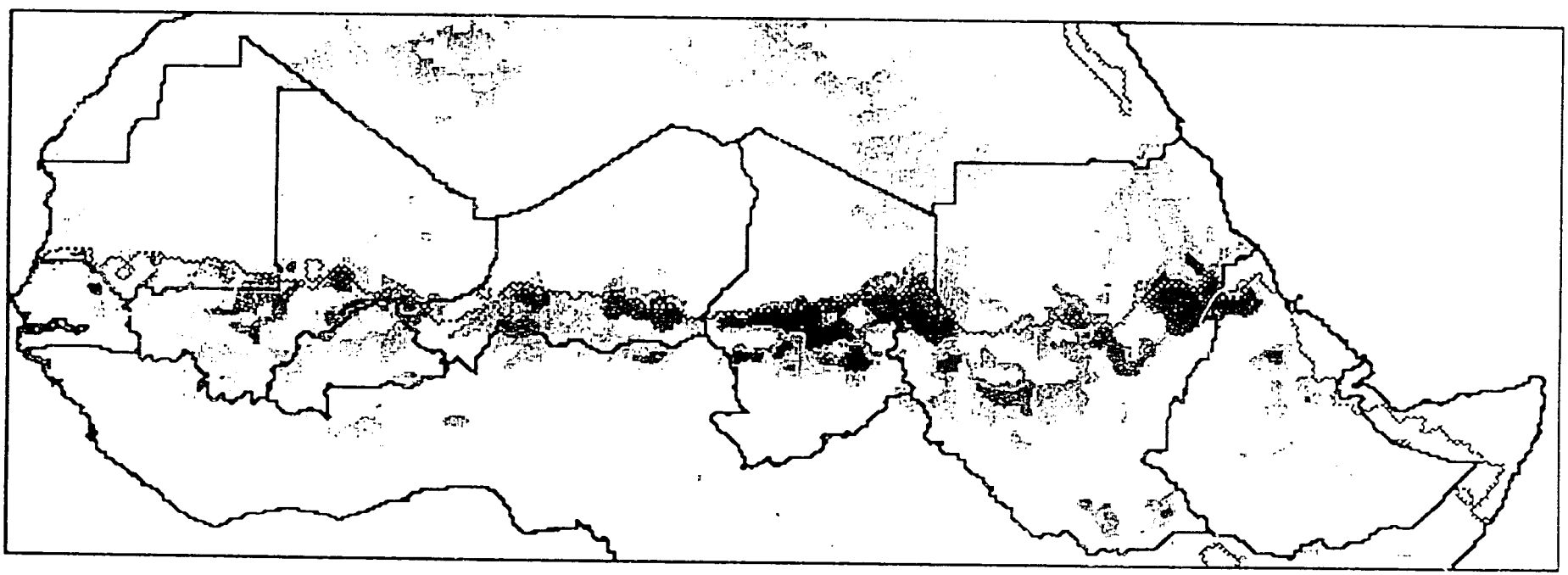
For Mauritania, 1988 has been one of the best crop years on record. Until there has been at least a representative assessment of crop damage, however, it will be difficult to make a prediction of food security with any certainty. With up to 50% of the country's food needs possibly provided by the current harvest, the overall need for food aid in 1989 may be sharply reduced from recent years. Many households that have ended previous years with a negative food balance (i.e., in debt) should be able to make ends meet. If 1989 rains are poor, the bulk of the population should at least be well-fed at the start of the 1989 harvest and better able to withstand hardship than in recent years. If the 1989 rains are as good as this years', households may even be able to produce a surplus. Repeated good rains may also support continued expansion of the grasshopper and Desert Locust populations. If 1989 pastures remain green through that year's harvest, the insects should have minimal effect on cereal production. Such a population growth among Desert Locusts, however, would continue a pattern that has locust control experts worried about a continuing series of plague years.

Regional Summary

From Mauritania east to Ethiopia, the FEWS-monitored countries report excellent rainfall (in terms of recent history) during the 1988 growing season. Satellite imagery showed vegetative potential to be very good, and in some areas better than the historical (1982-1987) maximum (see Map 13). While estimates vary, record production can be expected in Sudan, Chad, Niger, and Mali. Production is expected to be good or better in Ethiopia and Burkina. The only exception to this good agricultural year may be Mauritania, which is the only country where predictions of significant (at a national level) locust damage might be borne out. Mauritania, however, is a grain-importing nation even in the best of years.

The areas of greatest vulnerability currently lie where war and civil strife limit access to food. There is a famine among displaced people in and around the Southern Region of Sudan. In Ethiopia, civil war in Eritrea and Tigray continues to make populations there extremely vulnerable to famine. Elsewhere, vulnerable populations are more localized.

Regional NDVI Greater than Historical Maximum



Areas where 1988 NDVI reached levels significantly higher than the 1982-87 record

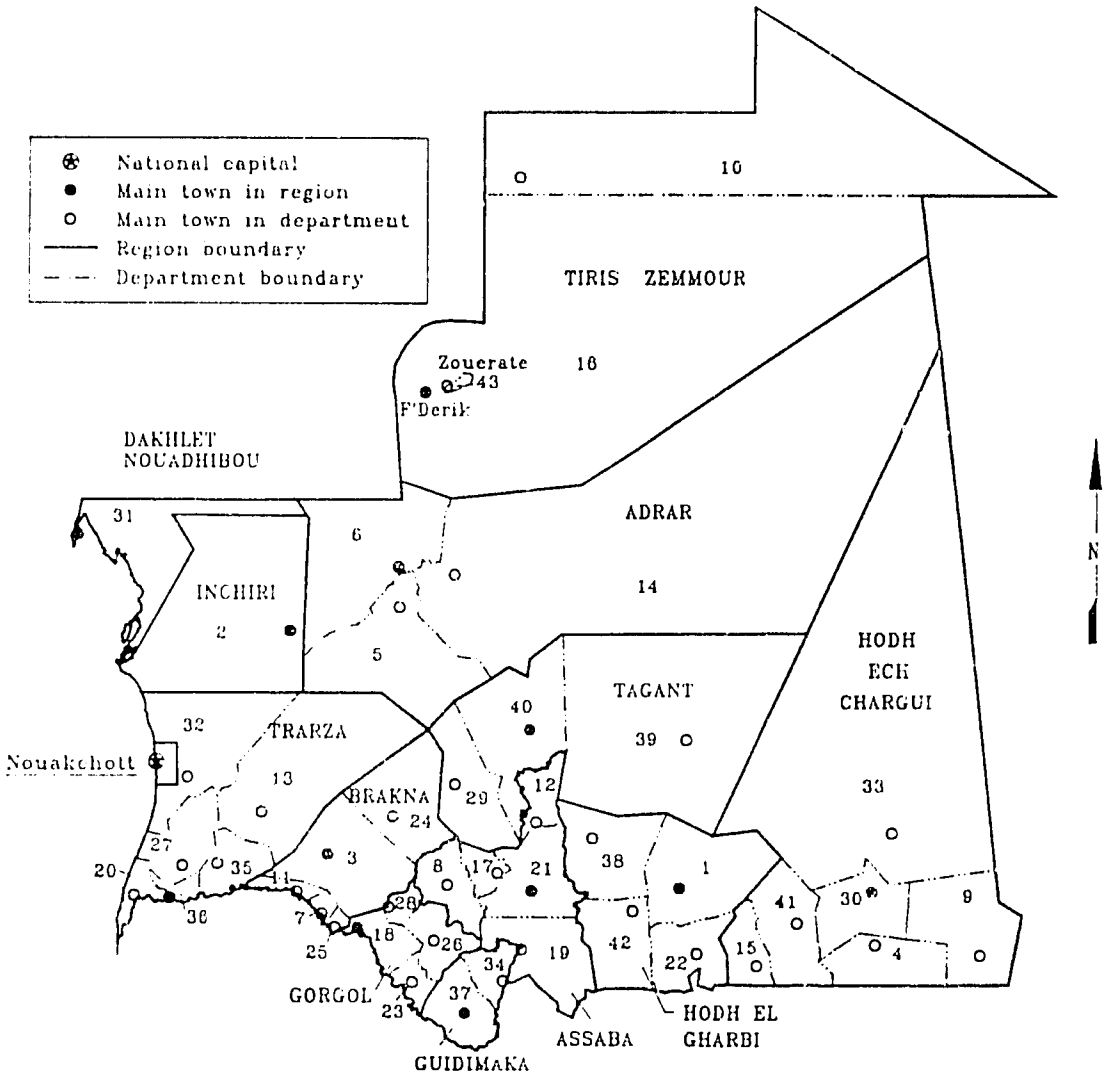
..... Historic northing of the 0.2 NDVI contour (which corresponds very closely with the 1988 contour)

Appendix 1

Acronyms used in this report:

AID	US Agency for International Development
AVHRR	Advanced Very High Resolution Radiometer
CEDS	GIRM/MEF/Bureau of National Statistics and Accountability
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CRS	Catholic Relief Services
CPS	GIRM/MRD/Crop Protection Service
CSA	GIRM/Food Security Commission
DivHyd	GIRM/MRD/SAH/Department of Hydrology
FADES	Arab Fund for Economic and Social Development
FAO	UN Food and Agriculture Organization
FEWS	AID's Famine Early Warning System Project for Africa
FFP	USAID/Food for Peace
FFW	Food-for-Work
GAC	Global Area Coverage
GIRM	Government of the Islamic Republic of Mauritania
IGN	National Geographic Institute (of France)
MEF	GIRM/Ministry of Economics and Finance
MRD	GIRM/Ministry of Rural Development
NASA	US National Aeronautic and Space Administration
NDVI	Normalized Difference Vegetation Index
NOAA	US National Oceanic and Atmospheric Administration
OAR	USAID/Office for Agricultural Resources
PVO	private voluntary organization
PWA	Price, Williams & Associates, Inc.
RSI	Remote Sensing Institute of South Dakota State University
SAH	GIRM/MRD/Bureau of Agrometeorology and Hydrology
SONIMEX	the national import/export agency of Mauritania
SSA	GIRM/MRD/Bureau of Agricultural Statistics
UM	Oughiya -- Mauritania's currency
UN	United Nations
UNDP	United Nations Development Program
UNSO	United Nations Sudano-Sahelian Office
USAID	AID's mission in Mauritania
WFP	UN World Food Program

Administrative Units
(Regions and Departments)



Department	RGN	Code	Department	RGN	Code	Department	RGN	Code
1. Aioun el Atrous	HG	021	16. F'Derik	TZ	112	30. Nema	HC	014
2. Akjoujt	IN	121	17. Guerou	AS	033	31. Nouadhibou	DN	081
3. Aleg	BR	051	18. Kaedi	GO	041	32. Ouad Naga	TR	064
4. Amourj	HC	011	19. Kankossa	AS	034	33. Oualata	HC	015
5. Aoujeft	AD	071	20. Keur Massene	TR	062	34. Ould Yenge	GU	101
6. Atar	AD	072	21. Kiffa	AS	035	35. R'Kiz	TR	065
7. Bababe	BR	052	22. Kobenni	HG	022	36. Rosso	TR	066
8. Barkewol el Abiod	AS	031	23. Maghama	GO	042	37. Selibaby	GU	102
9. Bassikounou	HC	012	24. Magta Lahjar	BR	054	38. Tamchekket	HG	023
10. Bir Mogrein	TZ	111	25. M'Bagne	BR	055	39. Tichit	TA	092
11. Boghe	BR	053	26. M'Bout	GO	043	40. Tidjikja	TA	093
12. Boumdeid	AS	032	27. Mederdra	TR	063	41. Timbedra	HC	016
13. Boutilimit	TR	061	28. Monguel	GO	044	42. Tintane	HG	024
14. Chinguetti	AD	073	29. Moudjeria	TA	091	43. Zouerate	TZ	113
15. Djiguenl	HC	013						

Source: GIRM/MEF/CEDS 1987 draft
FEWS/PWA, December 1988

Table A1: Cereal Balance Estimates for 1989, Several Scenarios

		MRD/SSA Prd Est	No Pest Loss[1]	10% Pest Loss[1]	30% Pest Loss[1] 165 kg	30% Pest Loss[1] 123 kg	FEWS Prd Est	No Pest Loss[1]	15% Pest Loss[1]	30% Pest Loss[1] 165 kg	30% Pest Loss[1] 123 kg
1989 Population = 1,926,000[2]											
Gross Production[3]		204,300					213,400				
Locust/Grasshopper Losses[1]			0	(20,300)	(60,900)	(60,900)		0	(31,800)	(63,600)	(63,600)
Seed[4]			(2,700)	(2,700)	(2,700)	(2,700)		(2,700)	(2,700)	(2,700)	(2,700)
Feed[4]			(8,000)	(8,000)	(8,000)	(8,000)		(8,000)	(8,000)	(8,000)	(8,000)
Processing Losses[5]			(41,600)	(27,300)	(28,700)	(28,700)		(43,000)	(36,300)	(29,600)	(29,600)
Net Production			152,000	136,000	104,000	104,000		159,700	134,600	109,500	109,500
Carry-Over Stock from 1988											
On-Farm[6]	10,000										
Private Merchants[6]	6,000										
CSA[7]	26,897										
SONIMEX[8]	6,191										
Total Carry-Over Stock		49,100					49,100				
Pledged Food Aid[9]											
Free Distribution, FFW, & PVO	12,000										
For Sale	49,000										
Total Pledged Aid		61,000					61,000				
Expected Cereal Imports[10]											
SONIMEX	65,000										
Commercial	40,000										
Total Expected Imports		105,000					105,000				
Total Supply Estimate			367,100	351,100	319,100	319,100		374,800	349,700	324,600	324,600
Per Capita Annual Consumption[11]			165 kg	165 kg	165 kg	123 kg		165 kg	165 kg	165 kg	123 kg
Projected Consumption			(317,8 0)	(317,300)	(317,800)	(236,900)		(317,800)	(317,800)	(317,800)	(236,900)
Cereal Balance Estimate			49,300	33,300	1,300	82,200		57,000	31,900	6,800	87,700
% Consumption needs met by Total Supply Estimate			115.5%	110.5%	100.4%	134.7%		117.9%	110.0%	102.1%	137.0%
Reconstitution Stocks[12]											
On-Farm	(10,000)										
Private Commercial	(6,000)										
Security Stock (CSA)	0										
Other (SONIMEX)	(16,500)										
Total Proposed		(32,500)					(32,500)				
Balance After Stocks Reconstituted			16,800	800	(31,200)	49,700		24,500	(600)	(25,700)	55,200

[1] It is not yet clear what effect this year's grasshopper and locust infestations will have on the harvest. Estimates of excess crop loss to grasshoppers and locusts range from 15 to 40% before harvest. Several estimates are used here to show the range of possible balances. Further assessment missions may be planned for January 1989.

[2] The 1989 population figure is based on a preliminary estimate from the MEF/CEDS 1987 census. The original CEDS figure was rounded to 1,870,000 and then increased at an annual growth rate of 3.0%.

[3] Gross 1988 Production: The MRD/SSA estimate uses the final estimate of 1987 lowland recession production as an approximation of the 1988 lowland recession harvest, while the FEWS figure uses the 1986 lowland recession estimate.

[4] Seed and feed reserve figures reported by FEWS/Mauritania.

[5] The standard processing loss figures were applied to production adjusted for seed, feed, and pest losses (15% for maize, millet, and sorghum and 40% for rice).

[6] Estimates from the 1988 cereal balance exercise are used here for on-farm and private commercial stock.

[7] This is the total of information supplied through November 12, 1988, and includes price support, free distribution, and security stocks. CSA distribution center stock figures are not all up-to-date. The various center accounts are current as of July through November, 1988.

[8] The SONIMEX figure is current as of October 31, 1988, and does not include local rice.

[9] Pledges are current as of December 8, 1988.

[10] Expected import figures reported by FEWS/Mauritania.

[11] Consumption rates: the 123 kg figure is an estimate of per capita consumption in 1986; 165 kg/yr/capita is the consumption rate used by the GIRM, FAO, and other donor organizations when programming food aid.

[12] Estimates from the 1988 cereal balance exercise are used here for reconstitution of on-farm and private commercial stocks. The SONIMEX figure is based on a 50,000 MT annual need and a four-month security stock.

Key Terms

At Risk - FEWS Reports employ the term "at risk" to describe those populations or areas either currently or in the near future expected to be lacking sufficient food, or resources to acquire sufficient food, to avert a nutritional crisis (i.e., a progressive deterioration in their health or nutritional condition below the status quo), and who, as a result, require specific intervention to avoid a life-threatening situation.

Where possible, food needs estimates are included in the FEWS reports. It is important to understand, however, that no direct relation exists between numbers of persons at risk and the quantity of food assistance needed. This is because famines are the culmination of slow-onset disaster processes which can be complex in the extreme. The food needs of individual populations at risk depend upon when in the disaster process identification is made and the extent of its cumulative impact on the individuals concerned. Further, the amount of food assistance required, whether from internal or external sources, depends upon a host of considerations. Thus the food needs estimates presented periodically in FEWS reports *should not* be interpreted to mean food aid needs, e.g., as under PL480 or other donor programs.

ITCZ - The Intertropical Convergence Zone (ITCZ) is where the high pressure system originating in equatorial regions of the Atlantic (the St. Helena's High) collides with the Azores High descending from the north. The ITCZ tends to move northward during the spring and summer in response to normal global weather patterns. The position of the ITCZ normally defines the northern limits of possible precipitation in the Sahel; rainfall generally occurs 100 to 300 kilometers south of the ITCZ.

NDVI - Normalized Difference Vegetation Index (NDVI) images are created at the laboratory of the National Aeronautic and Space Administration (NASA) Global Inventory Modeling and Monitoring System (GIMMS). These images are derived from Global Area Coverage (GAC) imagery (of approximately 4 km resolution) received from the Advanced Very High Resolution Radiometer (AVHRR) sensors on board the National Oceanic and Atmospheric Administration (NOAA) Polar Orbiting series of satellites. The polar orbiter satellites remotely sense the entire Earth and its atmosphere once each day and once each night, collecting data in 5 spectral bands. Bands 1 and 2 sense reflected red and infra-red wavelengths respectively, and the remaining 3 bands sense emitted radiation in 3 different spectral bands. The NDVI images are created by calculating

$$(\text{infrared} - \text{red}) / (\text{infrared} + \text{red})$$

for each pixel from the daytime satellite passes. Since chlorophyll reflects more in the infrared band than in the red band, higher NDVI values indicate the presence of more chlorophyll and, by inference, more live vegetation. A composite of daily NDVI images is created for each 10-day period, using the highest NDVI value for each pixel during that period. This technique minimizes the effects of clouds and other forms of atmospheric interference that tend to reduce NDVI values. NDVI is often referred to as a measure of "greenness" or "vegetative vigor." The NDVI images are used to monitor the response of vegetation to weather conditions.