

## Armyworm Emergency operation in Tigray

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Dr. Wolfgang Meinzingen, UN-EUE Consultant & Dr. Robert Shank, UN-EUE Field Officer, August 1994

### Biology and Epidemiology

The African armyworm is the larval stage of the night flying moth, *Spodoptera exempta*. The larvae or caterpillar, when occurring in large numbers, can consume rangeland grasses or wheat, barley, teff, maize, sorghum or finger millet crops faster than 400 head of cattle per hectare. After molting through six stages or instars over 14-22 days, the larvae pupate in the soil to emerge as moths which reinfest at the same place or several hundred kilometers downwind.

The seasonal cycle of the armyworm begins with the low density breeding of dry-season populations in the cool, coastal highlands of Kenya and Tanzania. These small populations of the solitary phase, which do little crop damage, occur in scattered grassy areas where it is not economical to spray or control them. As the Intertropical Convergence Zone begins moving northward causing the annual onset of the Meher rains, the strong winds accompanying the thunderstorms carry some moths to the interior highlands where primary outbreaks occur. Although not fully understood, it is here that the biological mechanism whereby a solitary pest transforms into the 40 times more active gregarious form takes place. It is thought that climatic changes at the onset of the rainy season, particularly when following a drought season, result in production of abundant forage which may trigger some response in the females laying the eggs. Because each female can lay 800-1000 eggs, as few as 30 moths could cause a serious outbreak of 15 million armyworms within two generations or two months.

During 1994, there were medium to large outbreaks in late March to early May in the Coastal, Nyanza and Rift valley provinces of Kenya which were monitored by the Desert Locust Control organization (DLCO) and sprayed by the Kenya Plant Protection Department. By mid-April major secondary outbreaks were causing serious damage in Eastern and Northern Uganda and Southeast Sudan. The first outbreaks in Ethiopia were recorded in Borena on 18 April, but not until mid-May did the movement encompass all of the Southern, Southwest, Ogaden and East/West Hararge areas. By 17 June, it was evident that a major control operation was needed as 240,000 hectares were affected and 170,000 liters/kilograms of pesticides were being distributed to the zonal capitols of the appropriate Regions (Table 1).

### Developments leading to the Northern campaign

The MoA-Plant Protection in Dessie reported low moth numbers in light/pheromone traps at Kamisa, Kombolcha, and Dessie but were prepared with 6,600 liters/kg of insecticide and 124 hand sprayers. On May 24, 7,065 hectares (1066 hectares being grassland) were 1020% infested and 1,314 hectares were already sprayed. However the Meher rains were delayed in the eastern escarpment areas and most maize and sorghum plantings were severely moisture stressed, thus providing little forage for the armyworms. Planting of short season crops had not yet begun so there would not have been substantial crop damage from armyworm even if outbreaks occurred.

On 15 June, Dr. Robert Shank of the EUE began a forecasting survey of South and North Wello and Tigray as reports were already being received of heavy infestations affecting about 40,000 hectares on the Gojjam-Gonder side.

In North Wello, the agronomist at Weldiya reported 5,559 hectares affected with 2,500 already sprayed. At hand were 32 sprayers and 5,900 liters/kg of pesticide. At Robit and Kobo, in North Wello, moth traps were being neglected and numbers were not being recorded. Again sorghum and maize crops were nearly beyond hope of recovering even if rain would come. Farmers expected to use the stalks as forage and replant teff or pulses when rainfall came.

In Region 1 (Tigray), there were moth counts of 831 on 3 June from the Western zone (Shire) and reports of 24,500 hectares affected (7,000 being cropland). A radio call on 24 June of an additional 5,000 hectares of affected cropland signaled an impending severe outbreak.

In the Central zone of Region 1, in Axum, a total of 3,500 hectares were affected. Five thousand litres of pesticide were sent to the zonal offices (2,200 to the western zone) and requests for additional assistance to the MoA-Addis Ababa brought the dispatch of 2,000 liters of pesticides. The DLCO spray plane arrived around 21 June. Ten drums of AvGas and 2,000 liters of pesticide were dispatched by DLCO to Mekele and Humera on 17 June.

### **Supplies Diminishing and Outbreaks Expanding**

On 17 June, at the regular FAO/DLCO/MOA meeting, it was reported that the outbreak of armyworm covered large areas of Borena, southern Bale, practically all of Hararge and iijiga, Sidamo and the omo area and parts of Jima and Welega. It was feared that pesticides of the MoA would be exhausted and an appeal was made to FAO and the donors for \$897,000, \$500,000 of which was for the purchase of chemicals, the rest for sprayers and safety equipment. The PAO agreed to contact Rome on an emergency basis but no donors were found.

On 30 June, at a specially called FAO meeting on the armyworm control campaign, while the spraying operations were known to be diminishing in the Hararge, South and Southwest, the report of 2,392 hectares affected by June 17 in Region 1 had grown to more than 40,000 hectares and was expected to reach 75,000 hectares by 4 July. Chemical supplies of the MoA-Plant Protection Department were said to be exhausted. The government had allocated Birr 1 million for spraying expenses. A recent donation of about 32,000 liters/kg of pesticides from the Government of South Korea had already been cleared through customs and allocated to the areas being sprayed. It appeared that all resources had been exhausted and the campaign would

soon end for lack of donors support for additional pesticide purchase. Shortly after the meeting, SIDA donated 1 million birr for the purchase from AISCO of 32,800 liters of pesticides.

### **Airlift and Aerial Spraying operations Organized by EUE**

With the knowledge of the strain already being placed on the single DLCO spray plane and an understanding of the historic food shortages in Region 1, it became apparent that help would be needed to transfer pesticides to Tigray and apply them in time to prevent severe crop damage. The window of time for application of pesticides in the case of armyworm is 7-10 days depending upon whether the infestation is spotted in the early instar stage and the air temperature where the larvae are developing. Dr. Meinzingen, the former head of the FAO regional migratory pest control project, was requested by FAO and the UN/EUE to come to Addis on 30 June for a 17 day consultancy to assist in forecasting and verification of outbreaks, coordination of aerial control operations, donor awareness and solicitation, and training of local personnel in forecasting and control operations.

Based on the report that 8-10,000 hectares were affected in the Humera area where UNHCR is resettling refugees, an emergency appeal was made to the Swiss Government to hire an additional spray aircraft from Ethiopian Airlines Spraying Service Unit (EA-SSU) and to transport fuel/pesticides to the area. The grant was received by Friday, July 1, the spray plane contracted on July 2 and moved to Axum 3 July for spraying 4 July. By that time, the infestation in Humera had pupated and the area affected around Axum and Shire had expanded. Therefore, it was decided to deploy the EA-SSU in this area with the following specifications:

	<b>DLCO</b>	<b>EA-SSU</b>
Fuel capacity	100 ltr	250 ltr
Fuel consumption Chemical capacity	80 ltr/hr(Avgas) 400 ltr	180 ltr/hr (Jet A-1) 1200 ltr
Application rate	.5 ltr/ha	.5 ltr/ha
Area Sprayed (ave 5 hr day)	500 ha/hour	1000 ha/hour <sup>1</sup>
Gross support supplies	1.6 MT/day	3.4 MT/day

<sup>1</sup> The area sprayed is larger due to air speed and the larger chemical tank necessitating fewer returns for refilling.

The rates charged by the EA-SSU are as follows:

spraying	5208 birr/hr
Ferry (to and from refilling site)	2435 birr/hr

Idle Guaranteed equivalent of two hours spraying/day unless weather/mechanical restrictions	1826 birr/hr
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With stocks of fuel and pesticide low in the area being sprayed, it was necessary to assist the MoA logistically in order to facilitate deliveries. Subsequently, an Ethiopian Airlines DHC-5 cargo aircraft was chartered by the UN-EUE to transport the necessary cargo. The chartered flights were scheduled on several occasions carrying the following cargo:

**Friday, 8 July, 1994**

Schedule: Addis - Shire - Axum - Mekele - Axum - Addis  
Cargo: Shire - 800 litres Avgas & 1000 litres ULV pesticide Axum - 1600 litres ULV & 2600 litres Jet A-1

**Saturday, 9 July, 1994**

Schedule: Addis - Shire - Mekele - Addis  
Cargo: 2400 litres ULV & 800 litres Avgas

**Sunday 10 July, 1994**

Schedule: Addis - Shire - Mekele - Shire - Addis  
Cargo: 800 litres ULV & 1400 litres EC (cargo from Mekele not known)

On 7 July, two trucks were dispatched from Addis Ababa, one by the MoA, transporting 6 drums (1200 litres) of Avgas and one by UN-EUE with 17 drums of ULV, 32 drums of malathion EC insecticide and 3,100 kgs of Carbaryl insecticide, the latter two allocated for ground application.

On 9 July, an Ethiopian Airlines Hercules was chartered to airlift 6000 litres of ULV, 3200 litres of Avgas and 532 backpack sprayers from Addis Ababa to Mekele. Transportation and distribution of this pesticide from Mekele to Axum, Shire and other places in need of spraying was by road.

Table 1. Area infested by Armyworms and area sprayed by region as of June 17, 1994<sup>1</sup> and as of July 10 (in **Bold**).

Region	# of Zones	# of weredas	Hectares Infested	Hectares Sprayed	Liters Insecticide	Kilograms Insecticide
1	2	6	2,392	1,200	698	661
	<b>4</b>	<b>27</b>	<b>75,000</b>	<b>18,522</b>	<b>6,967</b>	<b>664</b>
3	7	62	43,102	7,861	6,881	980
	<b>7</b>	<b>75</b>	<b>159,392</b>	<b>17,392</b>	<b>14,167</b>	<b>3,526</b>
4	11	92	87,077	57,940	55,638	7,440
	<b>12</b>	<b>92</b>	<b>510,025</b>	<b>74,048</b>	<b>90,041</b>	<b>16,595</b>
5	1	5	40,000	7,000	8,850	0
			<b>43,740</b>	<b>12,840</b>	<b>13,000</b>	
6	2	5	15,000	2,036	2,130	325
			<b>15,564</b>	<b>3,644</b>	<b>2,200</b>	<b>985</b>
Southern Peoples	10	39	46,773	15,675	12,238	4,733
	<b>11</b>	<b>58</b>	<b>50,000</b>	<b>26,104</b>	<b>22,156</b>	<b>10,420</b>
13	1	13	1,215	1,215	920	550
			<b>10,225</b>	<b>1,803</b>	<b>1,040</b>	<b>575</b>
Dire Dawa	1	2	4,674	4,674	3,722	1,900
					<b>4,045</b>	
Total	35	219	240,234	99,202	91,079	16,630
	<b>38</b>	<b>264</b>	<b>869,044</b>	<b>159,028</b>	<b>153,616</b>	<b>34,665</b>

<sup>1</sup>source:- Ministry of Agriculture-Sholla Plant Protection Laboratory

**Table 2. Aerial spraying operations in West and Central Zones of Region 1 (Tigray) from 28 June to 10 July, 1994.**

Date	Axum Zone		Shire Zone	
	DLCO	ESS	DLCO	ESS
6/28			2400	
6/29			1200	
6/30				
7/1			pilot sick	
7/2			pilot sick	
7/3	1200			
7/4				En Route
7/5	1400			1600
7/6			600	
7/7		3200		
7/8		Rainy	Fog-Rain	
7/9		4000	2000	
7/10		2000		

### Current situation, Forecasting and the Farmers response

During the course of control operations, all remaining stocks of ULV in the possession of the MoA and the AISCO were moved to the aerial operation sites. An additional 30,000 litres donated by the Government of Japan arrived at this point, to be processed and cleared for deployment in the affected region. Table 2 shows the areas that had been surveyed for spraying as of 8 July in Axum and Shire. Hand sprayers and EC pesticides for the operation were to be distributed from the available stocks previously transferred to Mekele. A remaining 20,000 hectares was to be hand sprayed in the Axum area and already targeted 26,000 hectares plus an additional 9,065 in the Shire area. Further increases in infestation in already affected areas were still expected although the worst was thought to be over with the observed decrease in moth numbers and the start of moderate rainfall which was perceived to be beneficial to crop growth but not for small armyworm larvae.

However, since rainfall had just begun in the Eastern and Southern Zones of Tigray as well as North and South Wello, at this point, outbreaks needed to be monitored through moth trappings and field observations. In fact, new outbreaks were still being reported in pocket areas of the Timbien area west of Mekele. Also, in Humera area, there was 8000 hectares of 1st generation larvae that was not sprayed so the larvae pupated in the ground and upon emergence could infest locally or move on to more northern areas.

**Table 3. Areas Surveyed for Aerial Armyworm Spraying in the Central and Western Zones of Region 1 (Tigray) as of 8 July.**

Central Zone (Axum)		Western Zone (Shire)	
Wereda	Area (hectares)	Wereda	Area (hectares)
Chila	3000	Adinebred	6118
Adi Arbaete	3301	Ade Hageray	4929
Adi Abun	1476	Ade Daero	4379
Edamariam	756	Medebai	2556
Maikintel	500	Asgede	7901
Endaba Tsahma	1600	L/Koraro	1925
Enticho	2711	T/Koraro	1710
Sprayed	12,000	MaiTsebri	3710
		Adi Wasla	1270
		Tsimbla	243
		Adi Remetz	324
<b>Total</b>	<b>24,400</b>		<b>35,065</b>
Sprayed as at 15/07	12,000		11,200
Allocated	12,000		14,800
Area infested suitable for aerial but ULV exhausted	400		9,065

### **Moth traps**

Pheromone moth traps are considered to be the simplest and least expensive method of predicting armyworm outbreaks. With this method, the synthetic female hormone attracts the male moth of only the armyworm, whereas light traps in addition to requiring electricity, attract many other species. When the number of male moths reaches 30 or more per day, a light outbreak becomes eminent within 7-10 days and second generation outbreaks occur which can be severe. During severe outbreaks, moth counts in the range of hundreds of moths per day are common.

Limited data on moth counts in several areas were made available to the author. Some trapping stations aggregate several days counts when emptying or reporting data. This makes it impossible to accurately predict exactly when outbreaks are likely to occur. Also, it distorts the pattern of a normal cycle of an outbreak. Although moths usually arrive with the winds of strong thunderstorms, if the storms occur over a period lasting several days, the breeding and egg laying may also be spread over a period of time and therefore, the rate of larval/pupal growth will become temperature and food-source dependent. Such factors tend to spread out moth counts for the second and subsequent generations. As all outbreaks in the regions, with the exception of Addis Ababa, occurred within a few days of the sharp rise in moth counts, they could have been forecast based available data. In highland areas such as Addis Ababa, moths arrived early enough to be detected and in large enough numbers to cause outbreaks but mating, egg laying and larval development were delayed and impeded by low temperatures.

The knowledge and control activities of the local farmer has proved to be remarkable. Farmers were warned of possible outbreaks by radio but as one farmer reported, he was already forewarned by observing the number of moths flying into the light of his evening coffee ceremony fire.

It is interesting to note from Table 4, the differences in the control practices of local farmers in comparison to the area covered by the airplanes as shown in Table 2. Cultural control is practiced mainly in regard to grassland outbreaks and consists of collecting larvae by hand which is sometimes fed to chickens, thrashing the area with thorn bushes or trampling with cattle. The area covered by either cultural control or ground spraying was small probably due to the early stage of the outbreak in Region 1 at the time of control. One farmer who was very encouraged to see the spray airplane remarked, In the past, airplanes came to kill us; this time it was good to hear the airplane coming to kill our enemy."

### **Economics of Armyworm Control and Lessons to be Learned**

Armyworm control will be an expenditure that the transitional government had not planned for and could do without. Immense loss was experienced through the use of several hundred thousand litres/kg of chemicals, costs of aerial and ground applications and the extensive manpower and labour directed toward saving crops rather than increasing production. Close to 1 million hectares may face reduced production due to complete or partial loss of crop leaf synthesizing area. CARE alone has been searching for short season crop seeds to replant 12,000 hectares of devastated crops, while expecting about 50% reduction in yield due to

shorter season crops. Also, many areas which normally have poor weed control will experience drastic broadleaf weed growth (not affected by armyworms) due to reduced cereal crop stands.

It may initially seem to be an expensive operation to airlift chemicals and fuel into areas that could also be supplied over land and with timely prepositioning. Also, utilization of the potential of the two aircraft was disappointingly low. However, when comparing the overall cost of the operation to the number of hectares of crop recovered, the operational cost averaged \$4 per hectare. Assuming the mixture of maize, sorghum and finger millet will average 10 quintals or 1 ton per hectare, the cost for a the programme to replacing this tonnage on site would be about \$130. The operation was therefore, both a reasonable investment and a move that spared Tigray, and possibly, Eritrea from catastrophe.

This brings us to lessons that we should recognize intellectually if not financially. It was after the drought of 1888-92, again in 1984, and now in 1993 that armyworm exercised its devastating effect with a migration across East Africa. Experts were fully aware of the problems in Kenya, Uganda and Sudan long before it reached Ethiopia. Possibly, the reluctance to become implicated in matters involving hazardous chemicals has been due to growing environmental awareness. Therefore, endemic organizations were not encouraged to preposition chemicals in the countryside to challenge this migratory pest.

In the words of one 1993 crop assessment expert, "Africa will have to become familiar with the agrichemical era in order to ensure the reliability of its much needed food supply".

Table 4. Armyworm infestation by crop and on-the-ground control activities in the Western Zone (Shire) as of July 7, 1994<sup>2</sup>.

Wereda	No Tabias	Area in Hectares					Cultural Control	No People	No Animals	liters chemical	Hectares	
		Millet	Sorghum	Maize	Pasture	Total					Sprayed	Total
Adinebred	10	3216	2088	814	193	6311	2	29	-	137	170	172
Adehageray	9	1754	2553	622	1944	6873	?	320	690	98	102	102+
Adedaero	6	1944	756	1697	1098	5477	33	5013	10783	55	162	195
Medebai	9	1692	496	368	1475	4031	104	3033	693	297	310	414
Asgede	9	3231	1244	3426	7475	15376	2	24	18	45	38	40
L/Koraro	6	1342	360	223	665	2590	17	602	200	46	49	66
T/Koraro	3	510	350	850	620	2330	11	80	350	24	24	35
Maitsebri	17	2180	1140	390	2354	6064	221	791	1535	230	298	519
Adiwasa	9	601	637	32	1325	2595	23	108	1847	63	60	83
Tsimbla	8	111	44	88	72	315	-	110	-	11	23	23
AdiRemetz	?	220	104	-	-	324	6	120	-	96	76	82
<b>Total</b>		<b>16801</b>	<b>9772</b>	<b>8510</b>	<b>17221</b>	<b>52286</b>	<b>419</b>	<b>10230</b>	<b>16116</b>	<b>1102</b>	<b>1312</b>	<b>1731</b>

<sup>2</sup> Data Provided by Zonal Ministry of Agriculture  
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